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ABSTRACT

This publication is designed to supplement the Comprehensive Small Engine Rapair guide by covering in detail all aspects of lawn and garden equipment repair not included in general engine repair or the repair of other small engines. It consists of instructional materials for both teachers and students, written in terms of student performance using measurable objectives. The course includes 13 units. Each instructional unit contains some or all of the basic components of a unit of instruction: performance objectives, suggested activities for teacher and students, information sheets, assignment sheets, job sheets, transparency masters, tests, and answers to the tests. Units are illustrated and are planned for more than one lesson or class period of instruction. An instructional/task analysis for lawn and garden equipment repair and a list of tools needed are provided for teacher information. Topics covered in the units are the following: basic hydraulic theory; hydraulic systems; maintaining the hydraulic system; equipment maintenance; brakes; clutches; transmissions (two-speed, three-speed, four-speed, and five-speed, and hydrostatic drives); front axles and steering; and equipment drives. (KC)

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ED219643

LAWN AND GARDEN EQUIPMENT REPAIR

by
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Developed by the
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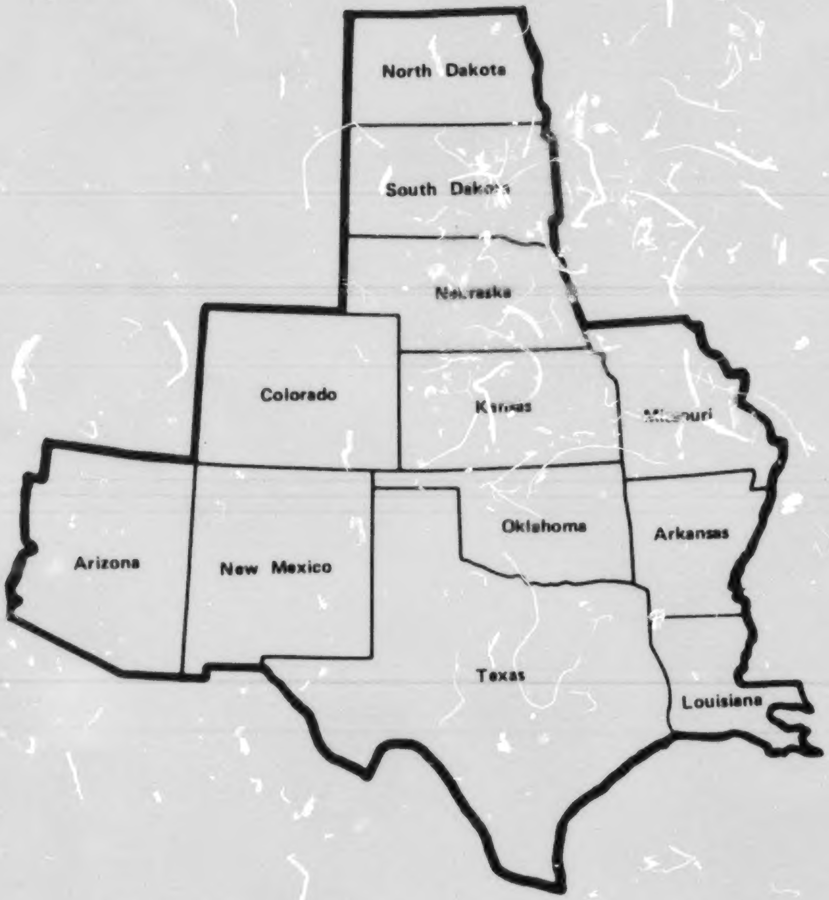
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FOREWORD

The Mid-America Vocational Curriculum Consortium (MAVCC) was organized for the purpose of developing instructional material for the twelve member states. Priorities for developing MAVCC material are determined annually based on the needs as identified by all member states. One of the first priorities identified was comprehensive small engine repair. This publication is a part of a project designed to provide the needed instructional material for small engine repair programs.

The success of this publication is due, in large part, to the capabilities of the personnel who worked with its development. The technical writers have numerous years of industry as well as teaching experience. Assisting them in their efforts were representatives of each of the member states who brought with them technical expertise and the experience related to the classroom and to the trade. To assure that the materials would parallel the industry environment and be accepted as a transportable basic teaching tool, organizations and industry representatives were involved in the developmental phases of the manual. Appreciation is extended to them for their valuable contributions to the manual.

This publication is designed to assist teachers in improving instruction. As these publications are used, it is hoped that the student performance will improve and that students will be better able to assume a role in their chosen occupation, small engine repair.

Instructional materials in this publication are written in terms of student performance using measurable objectives. This is an innovative approach to teaching that accents and augments the teaching/learning process. Criterion referenced evaluation instruments are provided for uniform measurement of student progress. In addition to evaluating recall information, teachers are encouraged to evaluate the other areas including process and product as indicated at the end of each instructional unit.

It is the sincere belief of the MAVCC personnel and all those members who served on the committees that this publication will allow the students to become better prepared and more effective members of the work force.

Bob Perry, Chairman
Board of Directors
Mid-America Vocational
Curriculum Consortium

PREFACE

For many years those responsible for teaching small engine repair have felt a need for instructional materials to use in this area. A team of teachers, industry representatives, and trade and industrial education staff members accepted this challenge and have produced manuals which will meet the needs of many types of courses where students are expected to become proficient in the area of small engine repair. The MAVCC *Lawn and Garden Equipment Repair* publication is designed to supplement the MAVCC *Comprehensive Small Engine Repair* publication by covering in detail all aspects of lawn and garden equipment repair not included in general engine repair or the repair of other small engines.

Every effort has been made to make this publication basic, readable, and by all means usable. Three vital parts of instruction have been intentionally omitted from this publication: motivation, personalization, and localization. These areas are left to the individual instructors and the instructors should capitalize on them. Only then will this publication really become a vital part of the teaching-learning process.

In addition, we would appreciate your help. We check for content quality, spelling, and typographical errors many times in the development of a manual. It is still possible, however, for an error to show up in a publication.

If, in the use of this publication, you should find something questionable we would appreciate you bringing it to our attention. A copy of the page or pages in question with your suggestions for correction would certainly help us when we revise and update materials.

We're trying to provide you with the best possible curriculum materials and will certainly appreciate your help in detecting areas where possible corrections are needed to maintain the quality you want and deserve.

Ann Benson
Executive Director
Mid-America Vocational Curriculum
Consortium, Inc.

ACKNOWLEDGMENTS

Appreciation is extended to those individuals who contributed their time and talents to the development of *Lawn and Garden Equipment Repair*.

The contents of this publication were planned and reviewed by:

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Gratitude is expressed to Regina Decker and Mary Kellum for editing and to the Graphics Division of the Oklahoma State Department of Vocational and Technical Education for typing.

Special appreciation goes to Jeanne Stewart and Barbara Boyce for the illustrations and drawings used in this publication.

The printing staff of the Oklahoma State Department of Vocational and Technical Education and the Oklahoma State Board of Affairs/Central Printing Division are deserving of much credit for printing this publication

USE OF THIS PUBLICATION

Instructional Units

The *Lawn and Garden Equipment Repair* curriculum includes thirteen units. Each instructional unit includes some or all of the basic components of a unit of instruction: performance objectives, suggested activities for teacher and students, information sheets, assignment sheets, job sheets, visual aids, tests, and answers to the test. Units are planned for more than one lesson or class period of instruction.

Careful study of each instructional unit by the teacher will help to determine:

A. The amount of material that can be covered in each class period.
B. The skills which must be demonstrated.
    1. Supplies needed
    2. Equipment needed
    3. Amount of practice needed
    4. Amount of class time needed for demonstrations
C. Supplementary materials such as pamphlets or filmstrips that must be ordered.
D. Resource people that must be contacted.

Objectives

Each unit of instruction is based on performance objectives. These objectives state the goals of the course thus providing a sense of direction and accomplishment for the student.

Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction and specific objectives, stating the student performance necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the intent of the objectives. A limited number of performance terms have been used in the objectives for this curriculum to assist in promoting the effectiveness of the communication among all individuals using the materials.

Following is a list of performance terms and their synonyms which may have been used in this material:

Name	Identify	Describe
Label	Select	Define
List in writing	Mark	Discuss in writing
List orally	Point out	Discuss orally
Letter	Pick out	Interpret
Record	Choose	Tell how
Repeat	Locate	Tell what
Give		Explain

Order
Arrange
Sequence
List in order
Classify
Divide
Isolate
Sort

Distinguish
Discriminate

Construct
Draw
Make
Build
Design
Formulate
Reproduce
Transcribe
Reduce
Increase
Figure

Demonstrate
Show your work
Show procedure
Perform an experiment
Perform the steps
Operate
Remove
Replace
Turn off/on
(Dis) assemble
(Dis) connect

Additional Terms Used
Evaluate
Complete
Analyze
Calculate
Estimate
Plan
Observe
Compare
Determine
Perform

Prepare
Make
Read
Tell
Teach
Converse
Lead
State
Write

Reading of the objectives by the student should be followed by a class discussion to answer any questions concerning performance requirements for each instruction unit.

Teachers should feel free to add objectives which will fit the material to the needs of the students and community. When teachers add objectives, they should remember to supply the needed information, assignment and/or job sheets, and criterion tests.

Suggested Activities

Each unit of instruction has a suggested activities sheet outlining steps to follow in accomplishing specific objectives. The activities are listed according to whether they are the responsibility of the instructor or the student.

Instructor: Duties of the instructor will vary according to the particular unit; however, for best use of the material they should include the following: provide students with objective sheet, information sheet, assignment sheets, and job sheets; preview filmstrips, make transparencies, and arrange for resource materials and people; discuss unit and specific objectives and information sheet; give test. Teachers are encouraged to use any additional instructional activities and teaching methods to aid students in accomplishing the objectives.

Students: Student activities are listed which will help the student to achieve the objectives for the unit.

Information Sheets

Information sheets provide content essential for meeting the cognitive (knowledge) objectives of the unit. The teacher will find that information sheets serve as an excellent guide for presenting the background knowledge necessary to develop the skills specified in the unit objective.

Students should read the information sheets before the information is discussed in class. Students may take additional notes on the information sheets.

Transparency Masters

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheets. They are particularly effective when identification is necessary.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion.

Job Sheets

Job sheets are an important segment of each unit. The instructor should be able to and in most situations should demonstrate the skills outlined in the job sheets. Procedures outlined in the job sheets give direction to the skill being taught and allow both student and teacher to check student progress toward the accomplishment of the skill. Job sheets provide a ready outline for students to follow if they have missed a demonstration. Job sheets also furnish potential employers with a picture of the skills being taught and the performances which might reasonably be expected from a person who has had this training.

Assignment Sheets

Assignment sheets give direction to study and furnish practice for paper and pencil activities to develop the knowledges which are necessary prerequisites to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided which may be used by the student and/or teacher for checking student progress.

Test and Evaluation

Paper-pencil and performance tests have been constructed to measure student achievement of each objective listed in the unit of instruction. Individual test items may be pulled out and used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the unit objective. Test items for objectives added by the teacher should be constructed and added to the test.

Test Answers

Test Answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.

LAWN AND GARDEN EQUIPMENT REPAIR
INSTRUCTIONAL/TASK ANALYSIS

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
SECTION A--UNIT I: HYDRAULICS	
	1. Terms
	2. Fluids
	3. Fluid qualities
	4. System types
	5. Hydraulic principles
	6. Force theory
	7. System components
	8. Fluid flow
UNIT II: HYDRAULIC SYSTEMS	
	1. Terms
	2. Specific components
	3. Hydraulic cylinders
	4. Hydraulic pumps
	5. Valves
	6. Open and closed center systems
	7. Fluid flow
UNIT III: MAINTAINING THE HYDRAULIC SYSTEM	
	1. Terms
	2. Test equipment
	3. System problems
	4. Customer service steps
5. Change system fluid	

JOB TRAINING: What the Worker Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
SECTION B--UNIT I: EQUIPMENT MAINTENANCE	
	1. Terms
	2. Types of equipment
	3. Basic maintenance procedures
4. Sharpen a rotary mower blade	
5. Service a battery	
6. Adjust a V-belt	
SECTION C--UNIT I: BRAKES	
	1. Types of brakes
	2. External band brake
	3. Disk brakes
	4. Drum and shoe brakes
5. Disassemble, inspect, and reassemble an external band brake	
6. Disassemble, inspect, and reassemble a drum and shoe brake	
SECTION D--UNIT I: CLUTCHES	
	1. Types of clutches
	2. Belt tension idler clutch
	3. Plate clutches
	4. Belt damage
5. Inspect and adjust a belt tension idler clutch	
6. Disassemble, inspect, and reassemble a plate clutch	

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
SECTION E--UNIT I: TWO SPEED TRANSMISSIONS	
	1. Terms
	2. Major parts
	3. Drive line maintenance
4. Disassemble, inspect, service, and reassemble a two-speed transmission	
UNIT II: THREE SPEED TRANSMISSIONS	
	1. Terms
	2. Parts
	3. Shift lever assembly
4. Disassemble and reassemble a shift lever assembly	
5. Disassemble, inspect, service, and reassemble a three speed transmission	
UNIT III: FOUR SPEED TRANSAXLES	
	1. Terms
	2. Parts
	3. Problem causes
4. Disassemble, inspect, reassemble, and test a four speed transaxle	
UNIT IV: IN LINE FIVE-SPEED TRANSMISSION	
	1. Terms
	2. Parts
3. Disassemble, inspect, repair, and reassemble an in line five speed transmission	
UNIT V: HYDROSTATIC DRIVES	
	1. Terms
	2. System components

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
	3. Types of systems
	4. Causes of malfunctions
	5. Fluid flow
6. Disassemble, inspect, repair, and reassemble an axial piston hydrostatic drive	
SECTION F--UNIT I: FRONT AXLES AND STEERING	
	1. Terms
	2. Major components
	3. Types of mechanisms
	4. Major components of cam and pin steering
	5. Wheel bearings and maintenance
	6. Front end alignment
7. Disassemble, inspect, and reassemble front axle and adjust toe-in	
8. Remove, disassemble, inspect, assemble, and reinstall steering gear	
SECTION G--UNIT I: EQUIPMENT DRIVES	
	1. Terms
	2. Types of drives
	3. PTO clutches
	4. Chain size classification
	5. Hydraulic motor drives
	6. Belt failures
7. Inspect, replace, and adjust a drive belt	
8. Remove, service, and replace a drive chain	

JOB TRAINING: What the Worker Should Be Able to Do
(Psychomotor)

9. Remove, test, and replace an electromagnetic PTO clutch

10. Repair PTO shaft universal joint

RELATED INFORMATION: What the Worker Should Know
(Cognitive)

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Section B--Equipment Maintenance

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Section C--Brakes

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Section D--Clutches

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Section F--Front Axles, Steering, and Alignment

Unit I Front Axles and Steering . . . . LG - 1-F

Section G--Equipment Drives

Unit I Equipment Drives . . . . LG - 1-G

TOOLS

(NOTE: These are the recommended tools and equipment necessary to complete the jobs required in these instructional materials.)

Hand Tool Assortment:
- One pound hammer - ball peen
- Slip joint pliers
- Screwdrivers
    - 4" standard
    - 1 1/2" standard
    - 8" standard
    - 6" standard
- Adjustable wrench
- Phillips screwdrivers
    - 6"
    - 1 1/2"
    - 8"
- 3/8" drive reversible ratchet
- 3/8" drive standard socket set
- 1/4" drive reversible ratchet
- 1/4" drive standard socket set
- 3/8" drive extension bar - 3 in.
- 3/8" drive extension bar - 7 1/2 in.
- Starter punch
- Cold chisel
- Combination wrench set 7/16 to 7/8 in.
- Universal joint
- Open end wrench set - metric
- 3/8 drive socket set - metric

Other Tools and Equipment:
- Safety glasses
- Combination wrench set - metric
- Vernier caliper
- Drain pan
- Brake cylinder hone
- Hex key
- Inside micrometer
- Outside micrometer
- Dial indicator
- End wrenches
- Impact screwdriver set
- Snap ring pliers
- Arbor press or bench vise
- Feeler gauge set
- Flat surface plate
- Machinist's steel rule
- Surface block
- Case divider tool
- Impact driver
- 3/8" drive phillips screwdriver socket
- Soft face hammer
- Tape measure
- Cleaning pan
- Cleaning brush
- Grease pan
- Plastic hammer
- Parts washing pan
- Pin wrench
- Seal driver set
- Meter/kilogram torque wrench
- Soft drift
- Nipple wrench
- Tire pressure gauge
- Bushing driver set
- Brass drift
- Pry bar
- Pliers
- Measuring container
- Hydraulic press
- Drift punch
- Surface plate
- Test lamp
- Ohmmeter
- Spark plug wrench
- Flywheel pullers
- 0-1" telescoping gauge
- Step plate
- Lint free towels
- Bushing remover and installer
- Battery tester
- Blade balances
- Funnel
- Oil pan

BASIC HYDRAULIC THEORY
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms to the correct definitions, list types of hydraulic fluids, and qualities they should possess. The student should also be able to identify basic hydraulic system components. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with hydraulic theory to the correct definitions.
2. List four types of hydraulic fluids used in lawn and garden equipment.
3. List desirable qualities of hydraulic fluids.
4. Select systems which use hydraulic force.
5. Select the basic principles of hydraulics.
6. Discuss hydraulic force theory when given illustrations.
7. Identify basic hydraulic system components.
8. Describe the fluid flow in an illustration of a simple hydraulic system.

BASIC HYDRAULIC THEORY
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheets.

   F. Show students examples of hydraulic applications.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM #1--Liquids

      2. TM #2--Basic Hydraulic System Components

   D. Test

   E. Answers to test

II. References:

A. *Hydraulics: Hydraulics Systems for Tractors and Other Mobil Equipment*, Care and Operation Vol. 1. Athens, Georgia: AAVIM, 1974.

B. Stewart, Harry L. and Storer, John M. *ABC's of Fluid Power*. Photofact Publications, New York, 1966.

C. *FOS Hydraulics*. Deere and Company, Moline, 1972.

BASIC HYDRAULIC THEORY
UNIT I

INFORMATION SHEET

I. Terms and definitions

   A. Liquid--Fluid substance which has no shape of its own

   B. Hydraulic fluid--Liquid used to transmit power and reduce friction

   C. Viscosity--Measurement of a liquid's ability to flow

   D. Drive piston--Pump piston which produces the system pressure

   E. Driven piston--Piston which applies force when under pressure from the pump

   F. Force--Pressure multiplied times driven piston area

   G. Pressure--The force that a cylinder exerts divided by the driven piston area; caused by attempting to compress a liquid or a gas

II. Types of hydraulic fluids used in lawn and garden equipment

   A. Gear oils

   B. Automatic transmission fluids

   C. Special oils and fluids from equipment manufacturers

   (NOTE: Manufacturers may recommend their brand of fluid to guarantee that their specifications for the system are met.)

   D. Crankcase oil

III. Desirable qualities of hydraulic fluids

   A. Freedom from contaminants

   B. Proper viscosity

   C. Oxidation resistance

   D. Rust and corrosion inhibitors

   E. Lubricating characteristics

   F. Antifoaming

   G. Protection for seals

INFORMATION SHEET

IV. Systems which use hydraulic force

- A. Hydrostatic drives
- B. Power steering
- C. Shock absorbers
- D. Hydraulic lifts
- E. Hydraulic motors
- F. Hydraulic brakes

V. Basic principles of hydraulics (Transparency 1)

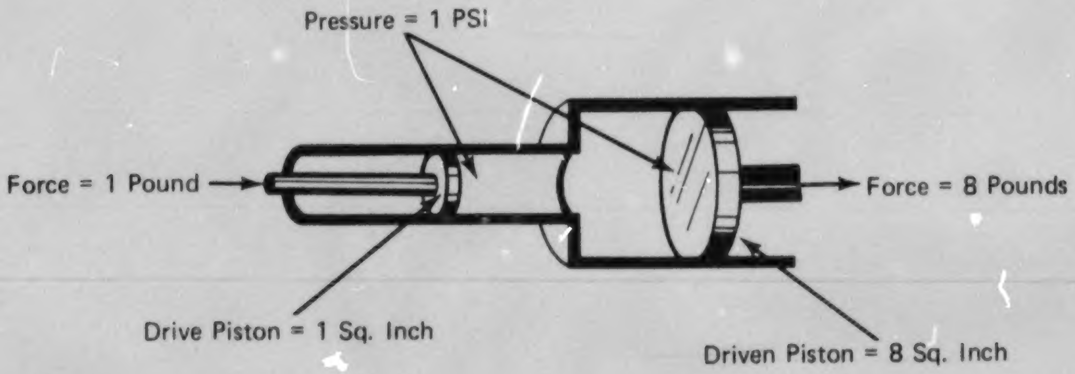
- A. Liquids have no shape of their own
- B. Liquids will not compress
- C. Liquids transmit applied pressure in all directions
- D. Liquids can provide increased work force

VI. Hydraulic force theory

(NOTE: These principles come from Pascal's Law.)

- A. The force applied to a driven piston is increased as its area increases

Example:

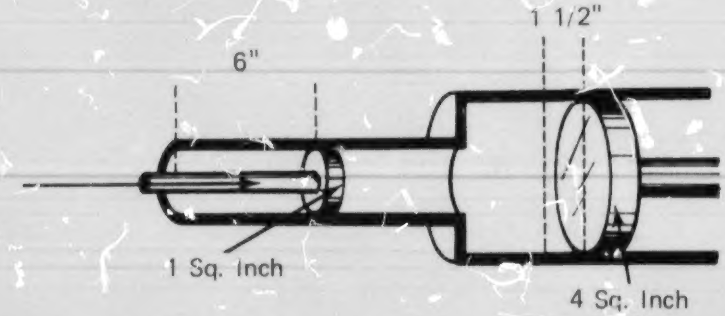

Pressure = 1 PSI
Force = 1 Pound
Force = 8 Pounds
Drive Piston = 1 Sq. Inch
Driven Piston = 8 Sq. Inch

Force = Pressure x Area of driven piston = 1 psi x 8 sq. in. = 8 lbs.

INFORMATION SHEET

B Driven piston movement is in direct proportion to the areas of the two pistons

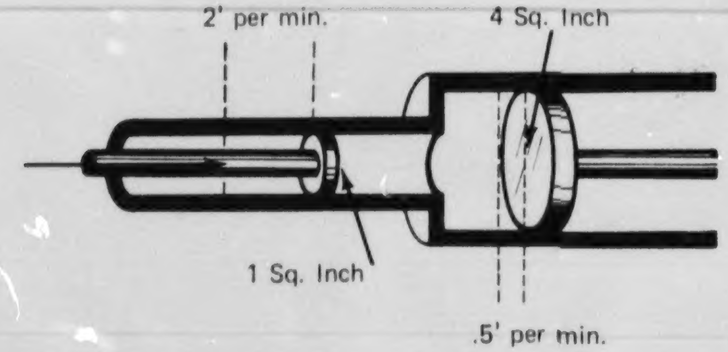
Example:


6"
1 1/2"
1 Sq. Inch
4 Sq. Inch

Movement = cu. in. of displaced fluid ÷ sq. in. area of driven piston;
Movement = 6 cu. in. ÷ 4 sq. in. = 1 1/2" movement

C. Rate of fluid flow to the driven piston determines its speed

Example:


2' per min.
4 Sq. Inch
1 Sq. Inch
.5' per min.

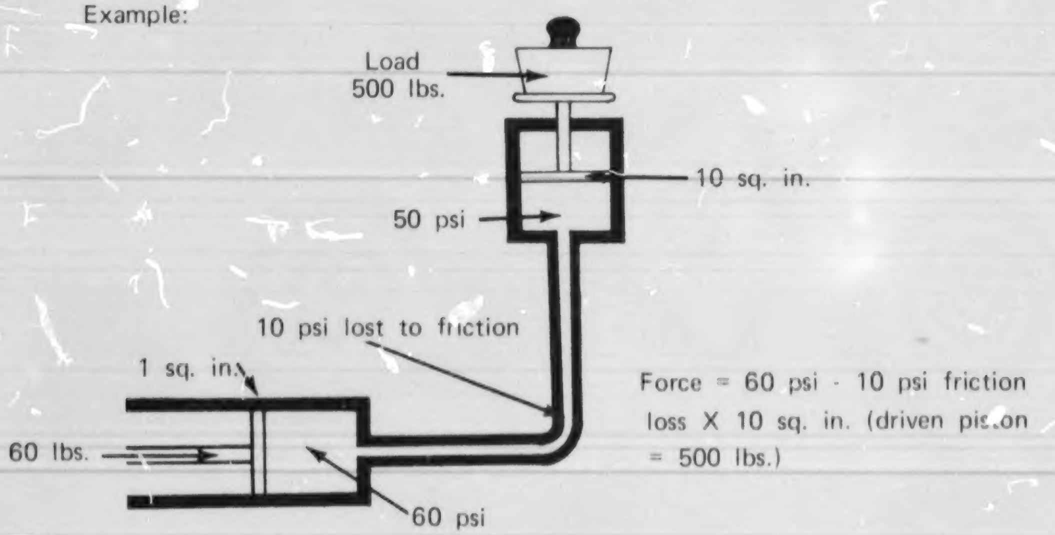
Driven Piston Speed = Drive piston speed x its area ÷ area of driven piston =
2' per min. x 1 sq. in. ÷ 4 = .5' per min.

INFORMATION SHEET

D. System pressure overcomes friction and moves loads

(NOTE: The resistance to fluid flow or friction causes some pressure loss.)

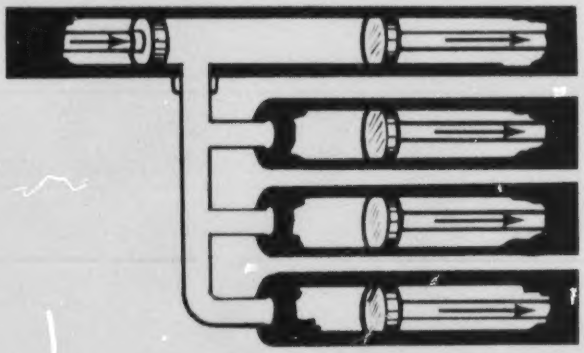
Example:


Load
500 lbs.
10 sq. in.
50 psi
10 psi lost to friction
1 sq. in.
60 lbs.
60 psi
Force = 60 psi - 10 psi friction loss X 10 sq. in. (driven piston = 500 lbs.)

E. Multicylinder systems with equal size driven cylinders and loads produce equal force and movement in each cylinder

(NOTE: There may be a slight variation due to resistance variations.)

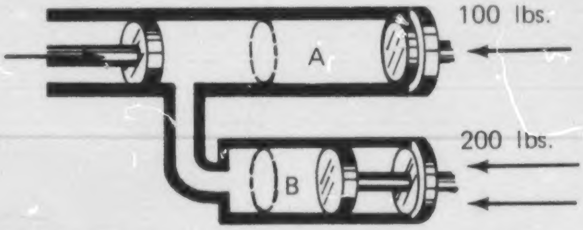
Example:



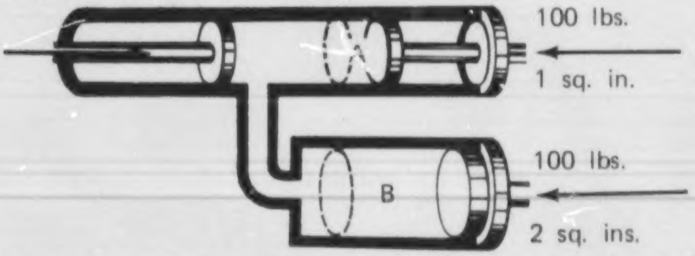
INFORMATION SHEET

F. Driven piston area and load determine the movement in multicylinder systems

Examples:



Given equal driven piston area and unequal load, the light load cylinder will complete ram travel before heavy load is moved



Givan unequal driven piston area and equal load the larger diameter piston will complete its travel before smaller piston moves

VII. Basic hydraulic system components (Transparency 2)

A. Load

B. Pump

(NOTE: These can be manually, motor, or engine driven as on most lawn and garden equipment applications.)

C. Cylinder

D. Control lever

E. Pressure relief valve

(NOTE: This valve opens if pressure builds up beyond a predetermined amount and causes fluid to circulate back to the reservoir.)

F. Reservoir

G. Control valve

(NOTE: The control valve directs pump pressure to the cylinder or circulates it back to the reservoir in this system.)

INFORMATION SHEET

VIII. Fluid flow in a simple hydraulic system (Transparency 2)

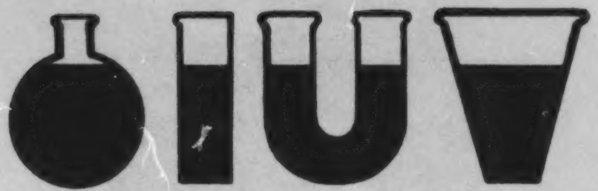
A. Control lever up

1. Pump picks up fluid in reservoir
2. Pump pressures oil through control valve
3. Fluid enters cylinder and applies pressure to driven piston
4. Load moves if pressure is great enough

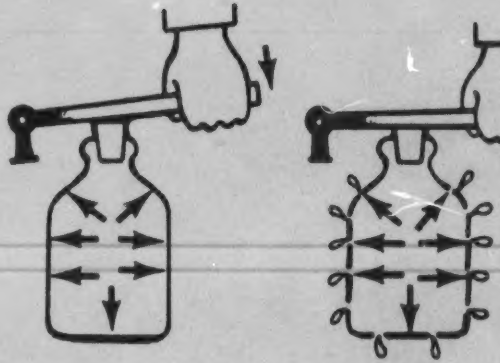
B. Control lever down

1. Pressure supply from pump is cut off
2. Load pressure pushes fluid through passage that is opened when lever was pushed down

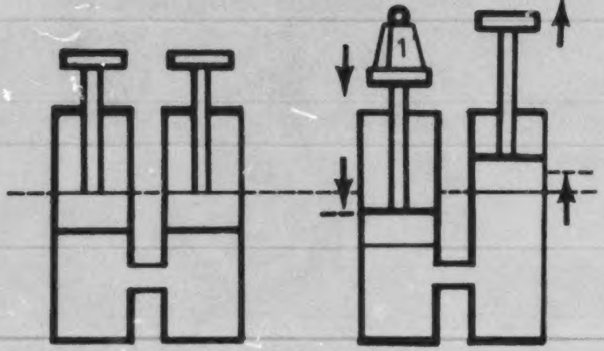
Liquids



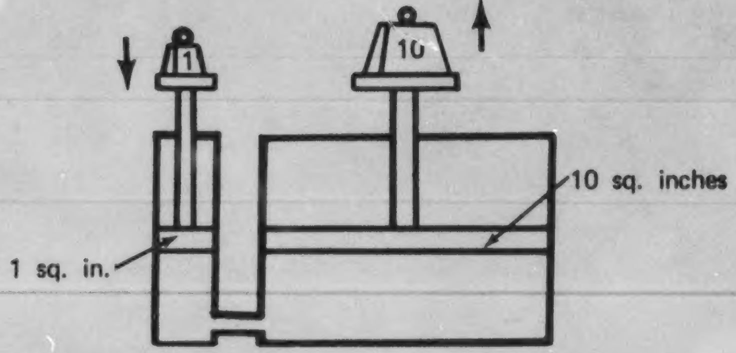
Have no shape of their own



Will not Compress



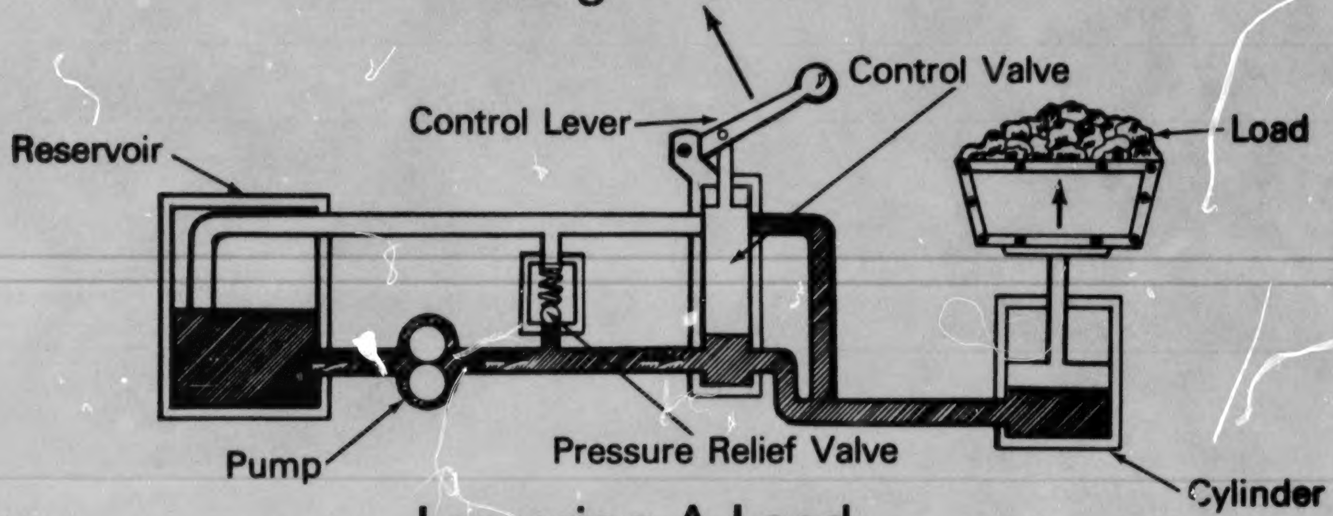
Transmit applied pressures in all directions


1
10
10 sq. inches
1 sq. in.

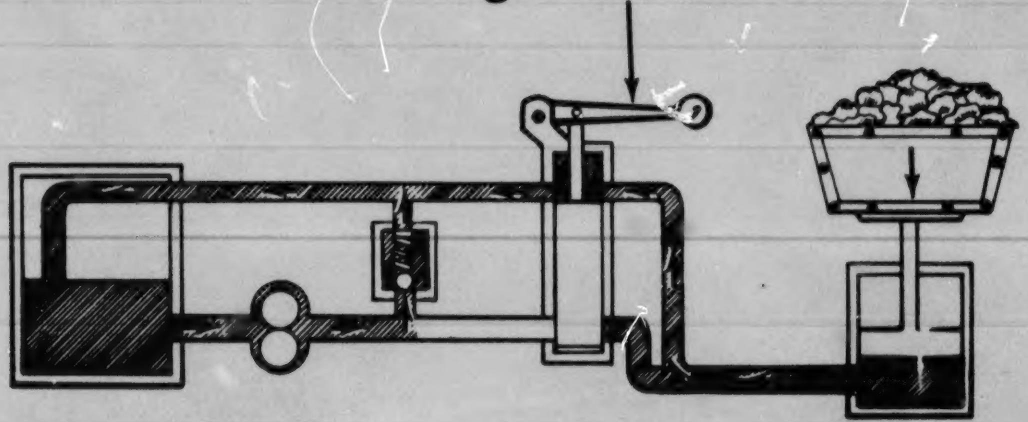
Can provide increased work force

Basic Hydraulic System Components

Lifting A Load


Control Valve
Control Lever
Load
Reservoir
Pump
Pressure Relief Valve
Cylinder

Lowering A Load



BASIC HYDRAULIC THEORY
UNIT I

NAME ______________________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. Fluid substance which has no shape of its own

_____b. Liquid used to transmit power and reduce friction

_____c. Measurement of a liquid's ability to flow

_____d. Pump piston which produces the system pressure

_____e. Piston which applies force when under pressure from the pump

_____f. Pressure multiplied times driven piston area

_____g. The force that a cylinder exerts divided by the driven piston area; caused by attempting to compress a liquid or a gas

1. Viscosity
2. Driven piston
3. Pressure
4. Hydraulic fluid
5. Force
6. Liquid
7. Drive piston

2. List four types of hydraulic fluids used in lawn and garden equipment.

a.

b.

c.

d.

3. List six desirable qualities of a hydraulic fluids.

   a.

   b.

   c.

   d.

   e.

   f.

4. Select systems which use hydraulic force by placing an "X" in the appropriate blanks.

   _____a. Power steering

   _____b. Alternator system

   _____c. Hydraulic lifts

   _____d. Shock absorbers

   _____e. Engine exhaust system

   _____f. Hydrostatic drives

   _____g. Hydraulic brakes

5. Select the basic principles of hydraulics by placing an "X" in the appropriate blanks.

   _____a. Liquids have no shape of their own

   _____b. Liquids will compress

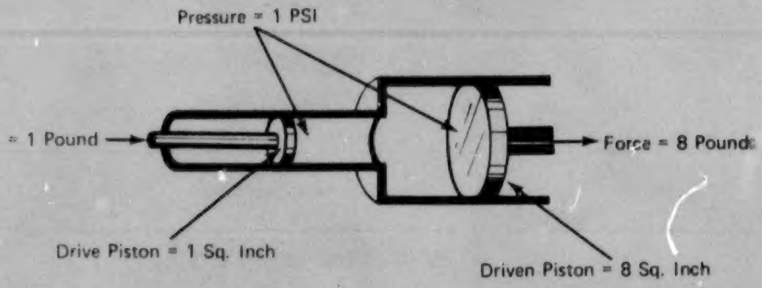
   _____c. Liquids transmit applied pressure in all directions

   _____d. Liquids can provide increased work force

   _____e. Liquids have a shape of their own

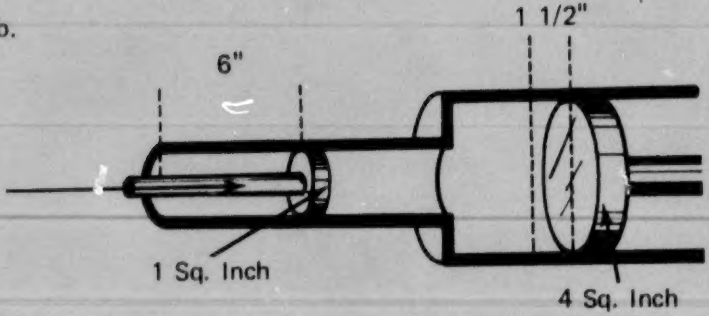
6. Discuss the hydraulic force theory using the following illustrations.

a.


Pressure = 1 PSI
= 1 Pound
Force = 8 Pounds
Drive Piston = 1 Sq. Inch
Driven Piston = 8 Sq. Inch

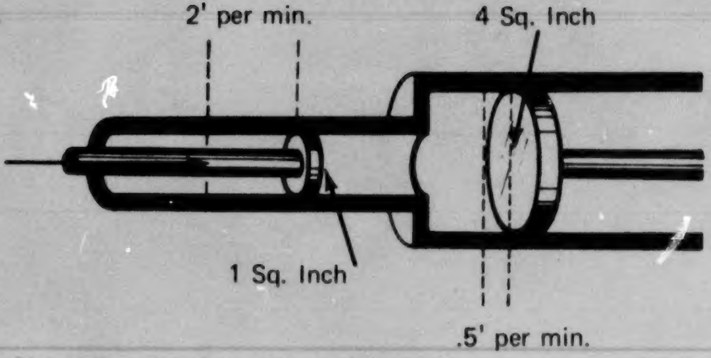
Force = Pressure x Area of driven piston = 1 psi x 8 sq. in. = 8 lbs.

b.


1 1/2"
6"
1 Sq. Inch
4 Sq. Inch

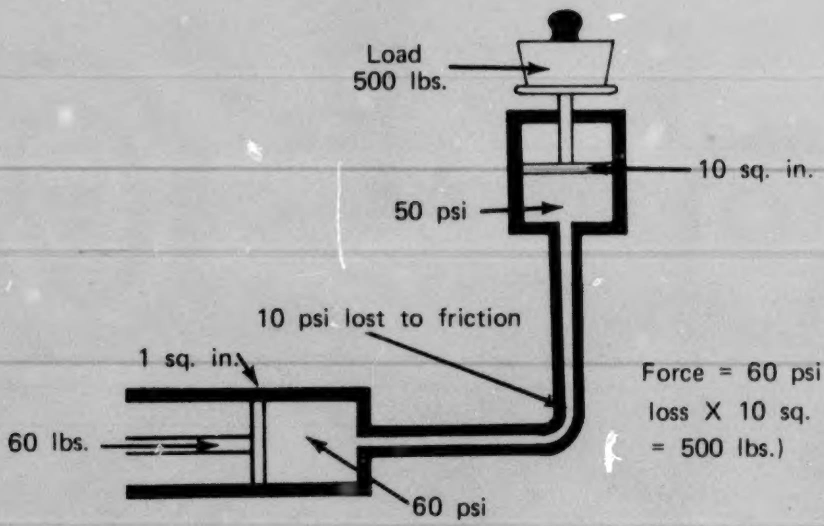
Movement = Cu. In. of displaced fluid ÷ Sq. In. area of driven piston;
Movement = 6 Cu. In. ÷ 4 Sq. In. = 1 1/2" movement

c.


2' per min.
4 Sq. Inch
1 Sq. Inch
.5' per min.

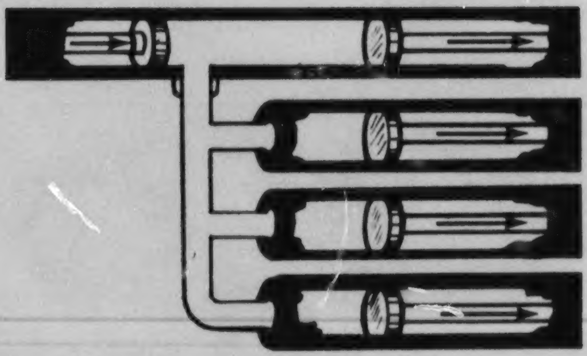
Driven Piston Speed = Drive Piston Speed X its area ÷ area of Driven Piston = 2' per min. X 1 Sq. In. ÷ 4 = .5' per min.

d.


Load
500 lbs.
10 sq. in.
50 psi
10 psi lost to friction
1 sq. in.
60 lbs.
60 psi

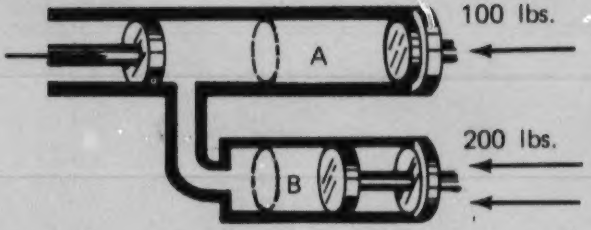
Force = 60 psi - 10 psi friction loss X 10 sq. in. (driven piston = 500 lbs.)

e.

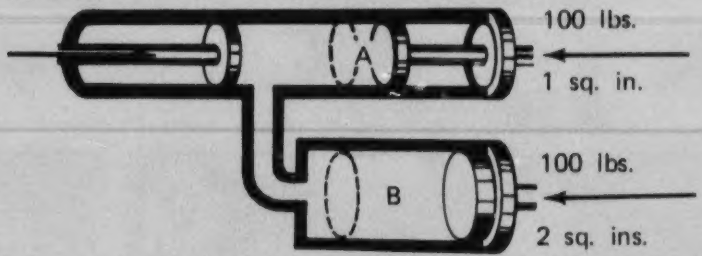


f.

Examples:

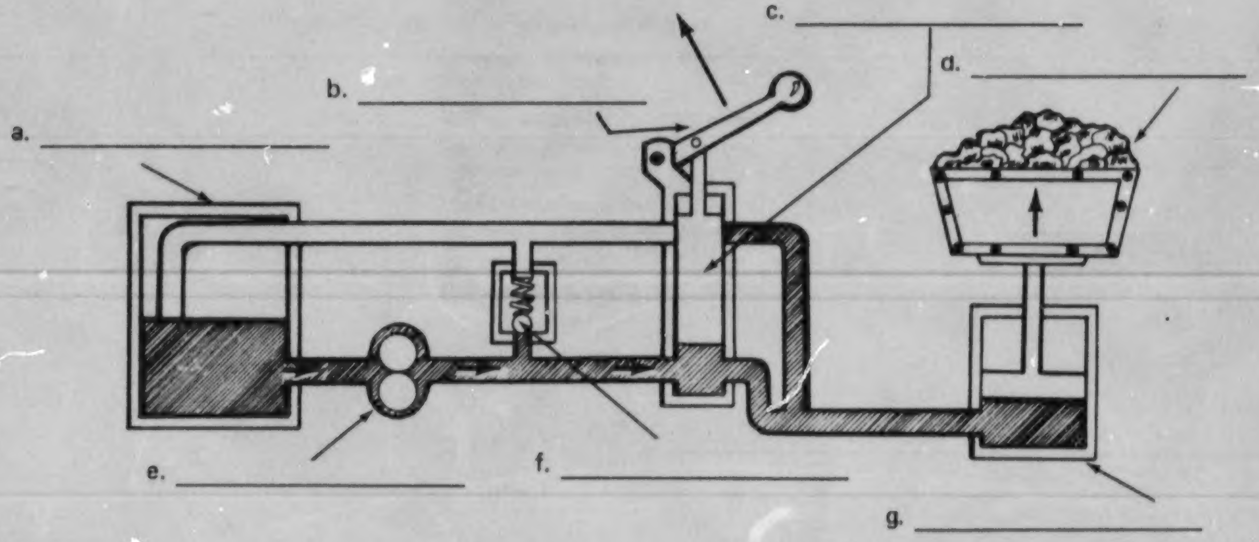

100 lbs.
A
200 lbs.
B

Given equal driven piston area and unequal load, the light load cylinder will complete ram travel before heavy load is moved

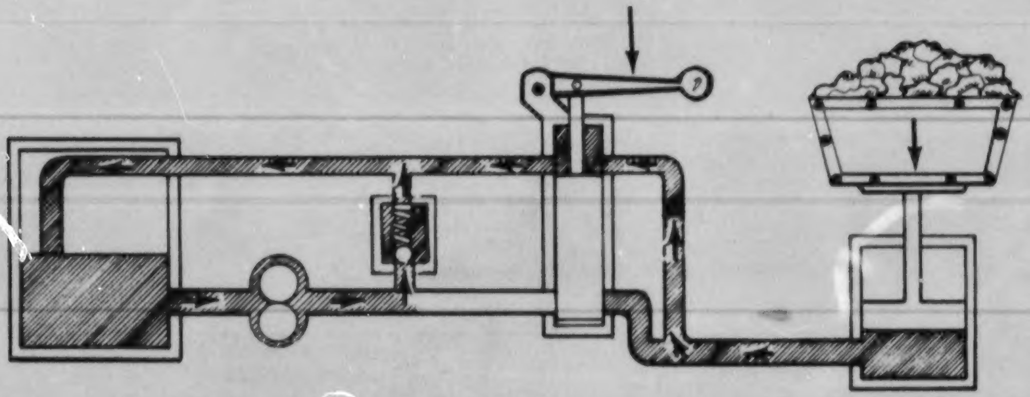

100 lbs.
A
1 sq. in.
100 lbs.
B
2 sq. ins.

Given unequal driven piston area and equal load the larger diameter piston will complete its travel before smaller piston moves

7. Identify the basic hydraulic system components.



8. Describe the fluid flow in the illustration of a simple hydraulic system.



BASIC HYDRAULIC THEORY
UNIT I

ANSWERS TO TEST

1. a. 6
   b. 4
   c. 1
   d. 7
   e. 2
   f. 5
   g. 3
2. a. Gear oils
   b. Automatic transmission fluids
   c. Special oils and fluids from equipment manufacturers
   d. Crankcase oil
3. Any six of the following:
   a. Freedom from contaminants
   b. Proper viscosity
   c. Oxidation resistance
   d. Rust and corrosion inhibitors
   e. Lubricating characteristics
   f. Antifoaming
   g. Protection for seals
4. a, c, d, f, g
5. a, c, d

6. Discussion should include:
    a. The force applied to a driven piston is increased as its area increases
    b. Driven piston movement is in direct proportion to the areas of the two pistons
    c. Rate of fluid flow to the driven piston determines its speed
    d. System pressure overcomes friction and moves loads
    e. Multicylinder systems with equal size driven cylinders and loads produce equal force and movement in each cylinder
    f. Driven piston area and load determine the movement in multicylinder systems
7. a. Reservoir
    b. Control lever
    c. Control valve
    d. Load
    e. Pump
    f. Pressure relief valve
    g. Cylinder
8. Description should include:
    a. Control lever up
        1. Pump picks up fluid in reservoir
        2. Pump pressures oil through control valve
        3. Fluid enters cylinder and applies pressure to driven piston
        4. Load moves if pressure is great enough
    b. Control lever down
        1. Pressure supply from pump is cut off
        2. Load pressure pushes fluid through passage that is opened when lever was pushed down

HYDRAULIC SYSTEMS
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify hydraulic system components, hydraulic cylinders, and parts of hydraulic pumps. The student should also be able to match terms, valve types, and systems to their definitions or descriptions. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with hydraulic systems to the correct definitions.
2. Identify specific hydraulic system components.
3. Identify types of hydraulic cylinders.
4. Identify parts of hydraulic pumps.
5. Match types of valves to their functions.
6. Distinguish between opened and closed center system characteristics.
7. Describe the fluid flow through a variable displacement axial piston pump when given illustrations.

HYDRAULIC SYSTEMS
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide student with objective sheet.
   B. Provide student with information sheet.
   C. Make transparencies.
   D. Discuss unit and specific objectives.
   E. Discuss information sheets.
   F. Show students examples of hydraulic system components.
   G. Give test.

II. Student:
   A. Read objective sheet.
   B. Study information sheet.
   C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objective sheet
   B. Information sheet
   C. Transparency masters
      1. TM 1--Types of Pumps
      2. TM 2--Types of Valves
      3. TM 3--Classes of Hydraulic Cylinders
      4. TM 4--Types of Hydraulic Motors
      5. TM 5--Types of Accumulators
      6. TM 6--Types of Filters
      7. TM 7--Locations of Reservoirs

8. TM 8--Types of Oil Coolers
9. TM 9--Types of Hoses
10. TM 10--Types of Fittings
11. TM 11--Types of Hydraulic Cylinders
12. TM 12--Parts of Hydraulic Pumps
13. TM 13--Opened and Closed Center Systems

D. Test

E. Answers to test

II. References:

A. *Hydraulics: Hydraulics Systems for Tractors and Other Mobil Equipment, Care and Operation, Vol. 1.* Athens, Georgia: AAVIM, 1974.

B. *Hydraulics: Hydraulics Systems for Tractors and Other Mobil Equipment, Inspecting and Testing Vol 2.* Athens, Georgia: AAVIM, 1974.

C. Stewart, Harry L. and Storer, John M. *ABC's of Fluid Power.* New York: Photofact Publications, 1966.

D. *FOS Hydraulics.* Moline, Illinois: Deere Company, 1972.

HYDRAULIC SYSTEMS
UNIT II

INFORMATION SHEET

I. Terms and definitions

- A. Nonpositive displacement pump--Transfers fluids but will not build pressure
- B. Positive displacement pump--Transfers fluids and will back up fluids causing pressure
- C. Fixed displacement--Pump which has a constant volume of flow
- D. Variable displacement--Pump which is capable of varying volume to equalize pressure
- E. Hydraulic pressure--Resistance to flow in a hydraulic system
- F. Valve--Device which controls either pressure of fluid, direction of fluid flow, or rate of flow
- G. Opened center system--System with control valve(s) which are open to continuous hydraulic flow, even in neutral position
- H. Closed center system--System with control valve(s) which are closed during neutral position, stopping fluid flow
- I. Accumulator--Reservoir for storing hydraulic fluid under pressure
- J. Servo--Device which provides automatic control of large amounts of power while using a small amount of power

II. Hydraulic system components

- A. Types of pumps (Transparency 1)
  1. Gear

     (NOTE: There can be either external or internal gear pumps.)
  2. Vane
  3. Piston
     - a. Radial
     - b. Axial

INFORMATION SHEET

B. Types of valves (Transparency 2)

   1. Pressure control

      (NOTE: These are used to limit, reduce or set pressure, or unload a pump.)

   2. Directional control

      (NOTE: These include check valves, rotary valves and spool valves.)

   3. Volume control

      (NOTE: These valves are used to control the volume of fluid flow or divide the flow between two or more circuits.)

C. Classes of hydraulic cylinders (Transparency 3)

   1. Piston type

      (NOTE: This cylinder gives straight movement.)

   2. Vane type

      (NOTE: This cylinder provides rotary movement.)

D. Types of hydraulic motors (Transparency 4)

   1. Gear
   2. Vane
   3. Piston
      a. Axial
      b. Radial

E. Types of accumulators (Transparency 5)

   1. Pneumatic
   2. Weight loaded
   3. Spring loaded

F. Types of filters (Transparency 6)

   1. Wire mesh
   2. Cotton waste
   3. Pleated paper

INFORMATION SHEET

4. Metal edge
5. Cannister

G. Locations of reservoirs (Transparency 7)

1. Separate tank
2. Transmission case
3. Equipment frame

   (NOTE: Most lawn and garden equipment has the reservoir in the transmission.)

H. Types of oil coolers (Transparency 8)

1. Water
2. Air

I. Types of hoses (Transparency 9)

1. Fabric braid
2. Single wire braid
3. Double wire braid
4. Spiral wire

J. Types of fittings (Transparency 10)

1. Male coupler
2. Female coupler
3. Permanent

   (NOTE: These are discarded with worn hoses.)

4. Reusable

   (NOTE: These can be removed from worn hoses and put on new ones.)

5. Medium pressure
6. High pressure (notched)

INFORMATION SHEET

III. Types of hydraulic cylinders (Transparency 11)

A. Single acting

(NOTE: This cylinder applies force in only one direction.)

B. Double acting

(NOTE: The direction of ram travel is determined by the direction of fluid flow to the ports.)

C. Telescoping

(NOTE: Hydraulic force moves largest piston first making the pistons raise the shafts in succession with the smallest diameter piston raising last.)

IV. Parts of hydraulic pumps (Transparency 12)

A. Axial piston

(NOTE: These pumps are used for high speed, high pressure systems. They often use the gear pump as a charge pump. They can be designed for fixed or variable flow.)

1. Port A (system return)
2. Pistons
3. Cylinder block
4. Variable swash plate
5. Charging pump
6. Port B
7. Check valves

B. External gear

(NOTE: Gear pumps are the most commonly used of all hydraulic pumps. They have a fixed displacement and are used individually or as charging pumps for larger pumps.)

1. Drive gear
2. Driven gear

   (NOTE: These are commonly called displacement gears.)

3. Housing

INFORMATION SHEET

4. Inlet port
5. Outlet port

C. Internal gear (rotor version)

1. Pump body
2. Outer rotor ring
3. Inner rotor
4. Rotor drive
5. Inlet port
6. Outlet port

V. Types of valves and their functions

A. Pressure control

(NOTE: Hydraulic systems are designed to operate at a certain pressure. Pressure control valves are used to keep the system from overpressuring and damaging the system.)

1. Limit system pressure
2. Reduce pressures

   (NOTE: These valves come in two designs, fixed reduction (reduces pressures by a specified amount), and constant reduction (reduces pressures to a preset amount).)

3. Determine pressure for circuit

B. Directional control--Determines or limits fluid direction in a circuit

(NOTE: Spool, check, and unloading valves are the main types of directional control valves.)

C. Flow control

1. Control volume of fluid in circuit

   (NOTE: These are generally used to cut off or restrict fluid flow.)

2. Divide fluid into other circuit paths

   (NOTE: Flow control valves are used in systems where two or more cylinders work simultaneously.)

INFORMATION SHEET

VI. Opened and closed center systems (Transparency 13)

A. Opened-center system

1. Control valve spool is open in the center to allow fluid return to reservoir in neutral

2. Works with constant flow pumps (fixed displacement)

3. Pressure is varied, flow is constant

B. Closed center system

1. Control valve dead ends pump in neutral

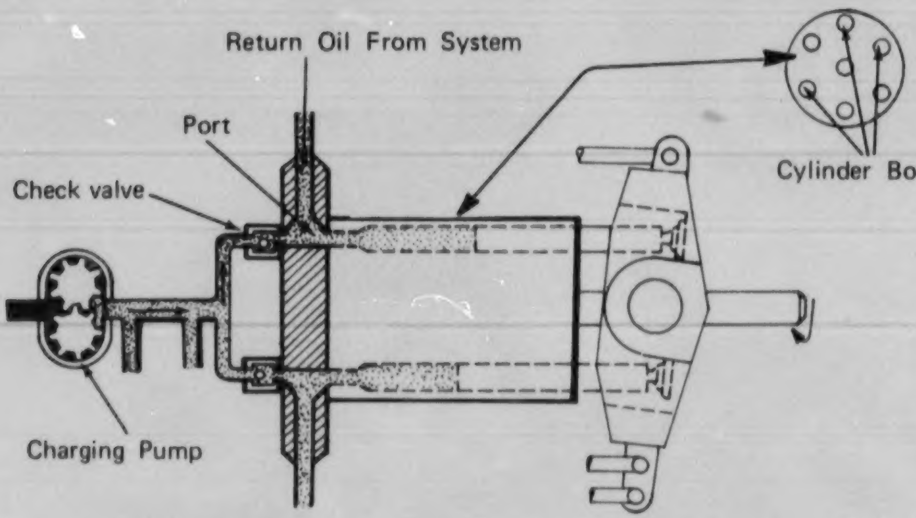
2. Works best with variable displacement pump

3. Flow varies, pressure is constant

VII. Fluid flow through a variable displacement axial piston pump

A. Charging pump pulls oil from reservoir and forces it through a check valve where it mixes with return oil at inlet port (Figure 1)

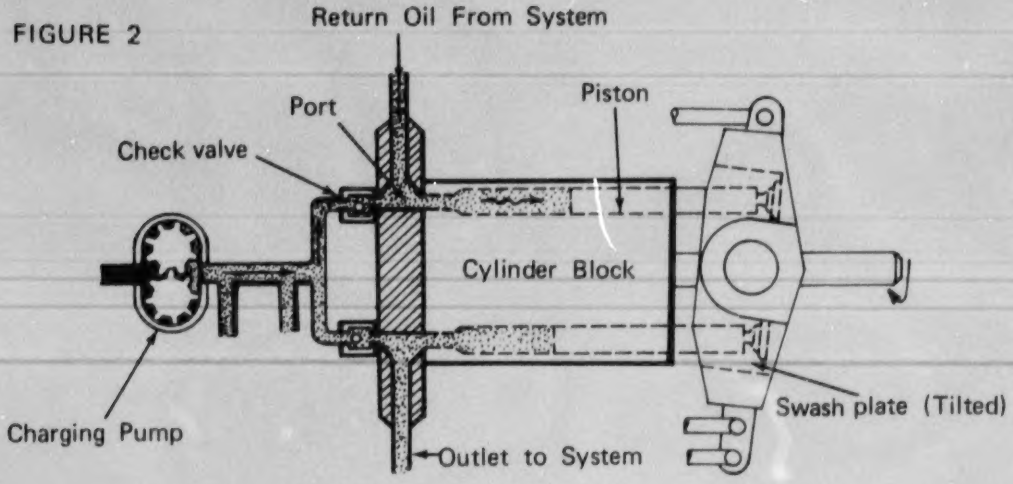
FIGURE 1


Return Oil From System
Port
Check valve
Cylinder Bores
Charging Pump

INFORMATION SHEET

B. As the cylinder rotates the piston bores align with the port and the charging pressure forces the pistons back against the swash plate (Figure 2)

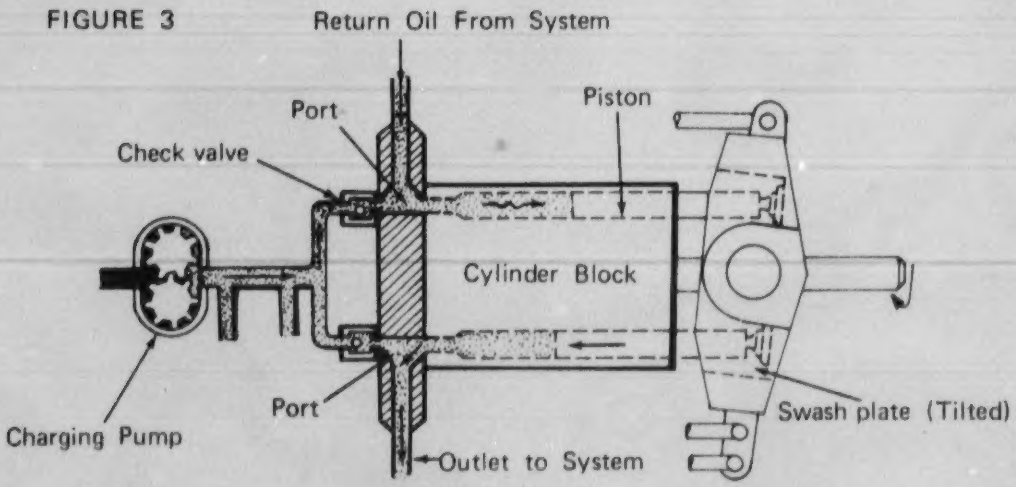
FIGURE 2


Return Oil From System
Port
Piston
Check valve
Cylinder Block
Charging Pump
Swash plate (Tilted)
Outlet to System

C. As the cylinder block continues to rotate, pressure develops as the pistons compress against the fluid due to the angle of the swash plate

D. When the piston bores align with the outlet port the fluid is forced under pressure into the system (Figure 3)

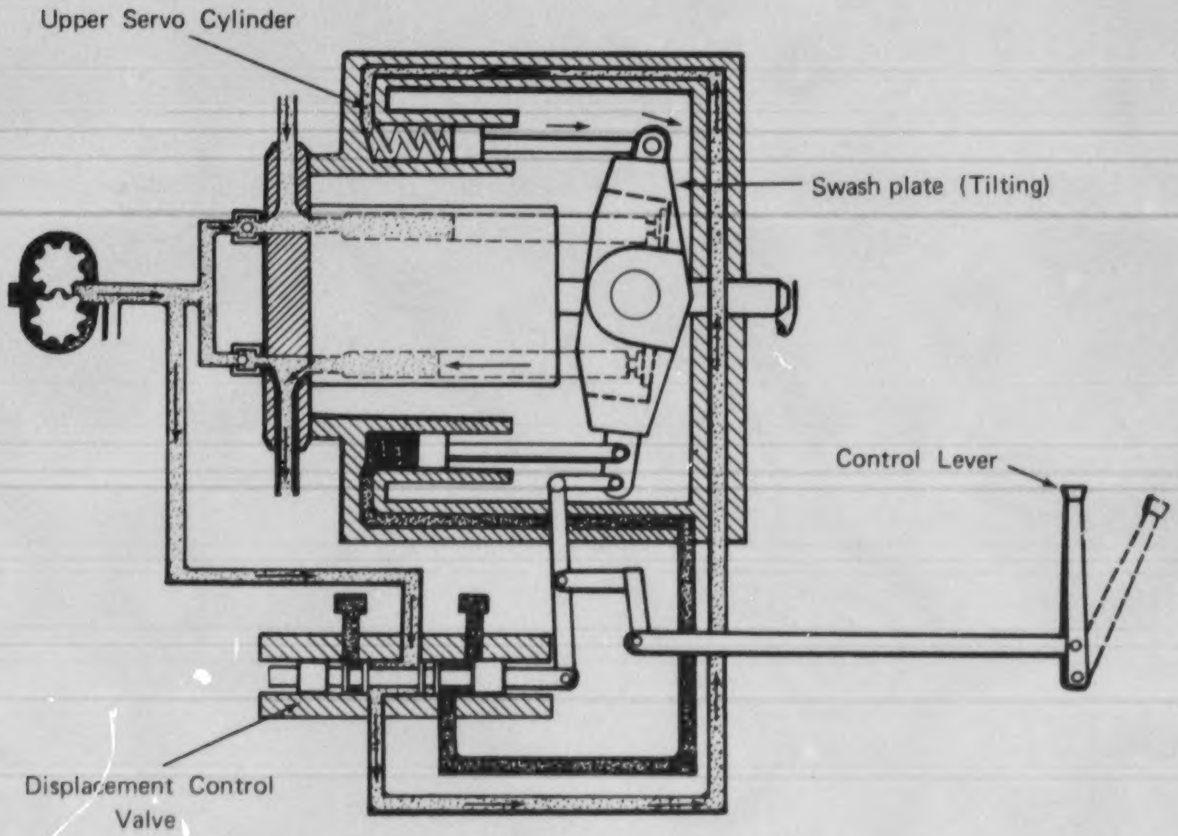
FIGURE 3


Return Oil From System
Port
Piston
Check valve
Cylinder Block
Port
Charging Pump
Swash plate (Tilted)
Outlet to System

INFORMATION SHEET

E. When the control lever is pulled to the left it pulls the displacement control valve to the left allowing fluid to flow to the upper servo cylinder (Figure 4)

FIGURE 4

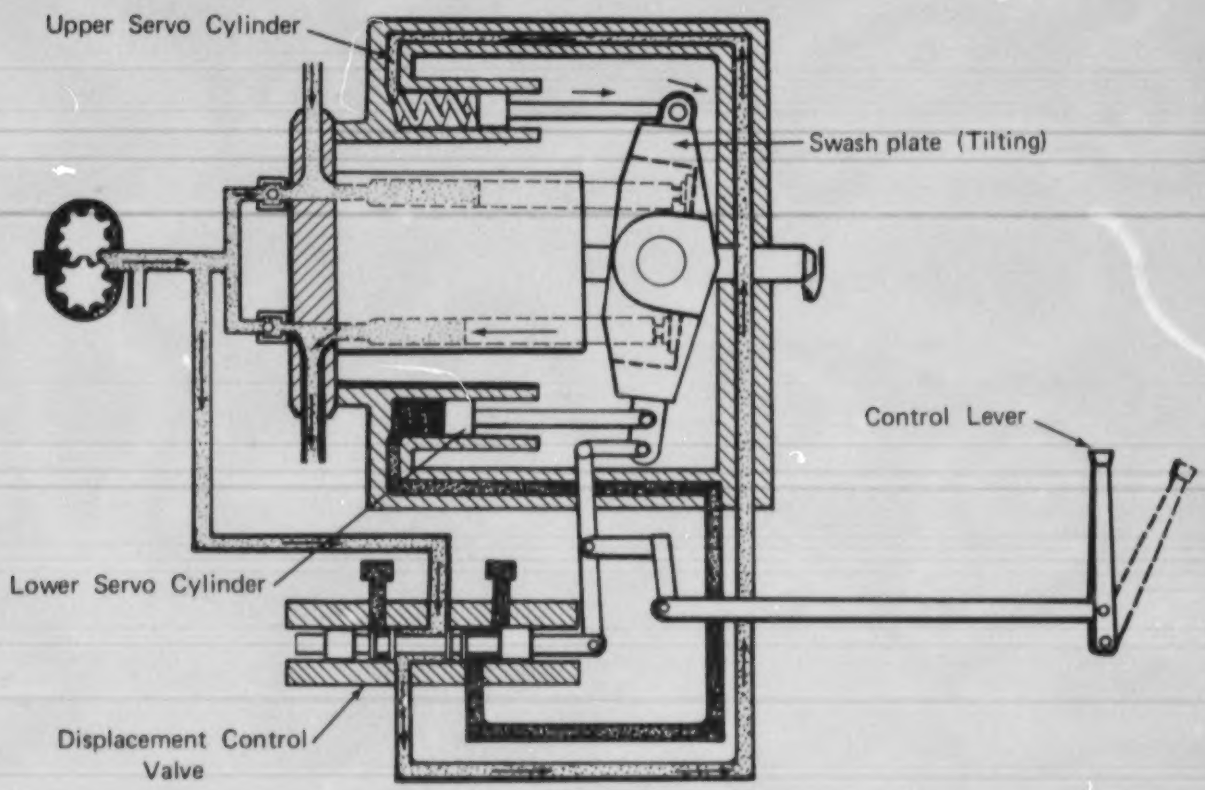

Upper Servo Cylinder
Swash plate (Tilting)
Control Lever
Displacement Control Valve

INFORMATION SHEET

F. The upper servo tilts the swash plate which forces fluid from the lower servo (Figure 5)

(NOTE: Reverse operation of the control lever would reverse servo operation and swash plate tilt.)

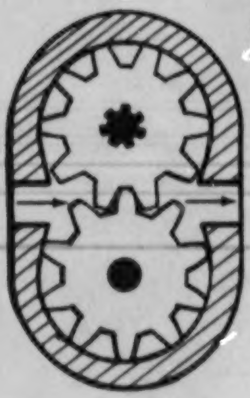
FIGURE 5


Upper Servo Cylinder
Swash plate (Tilting)
Control Lever
Lower Servo Cylinder
Displacement Control Valve

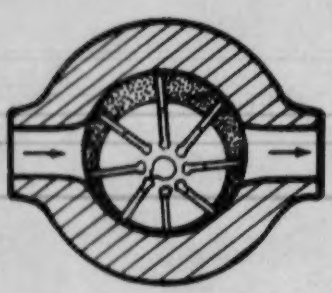
G. When the control lever is released the displacement control valve returns to neutral, trapping the oil in the servos and locking the swash plate angle

(NOTE: Swash plate tilt determines quantity of flow volume from pump.)

Types of Pumps

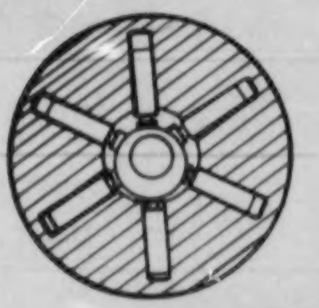


Gear

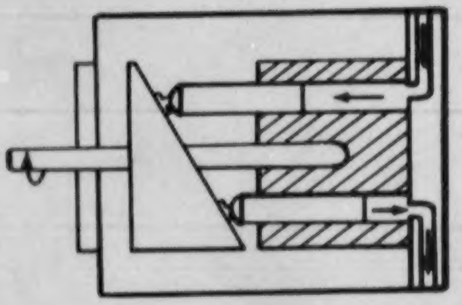


Vane

Piston

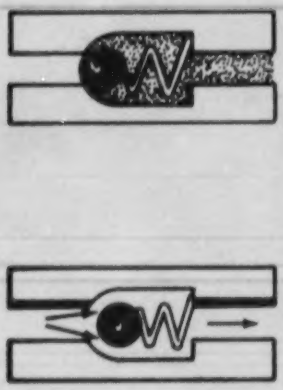


Radial

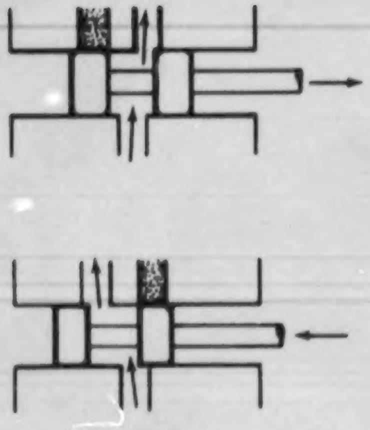


Axial

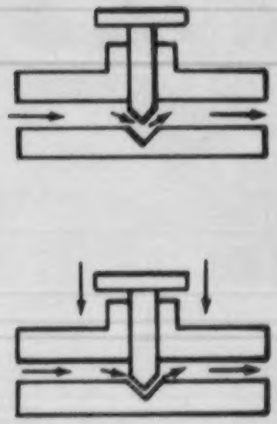
Types of Valves



Pressure Control

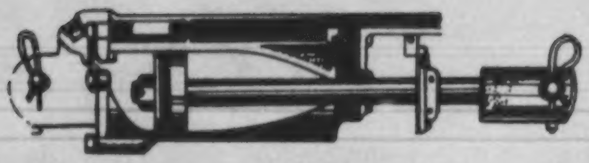


Directional Control

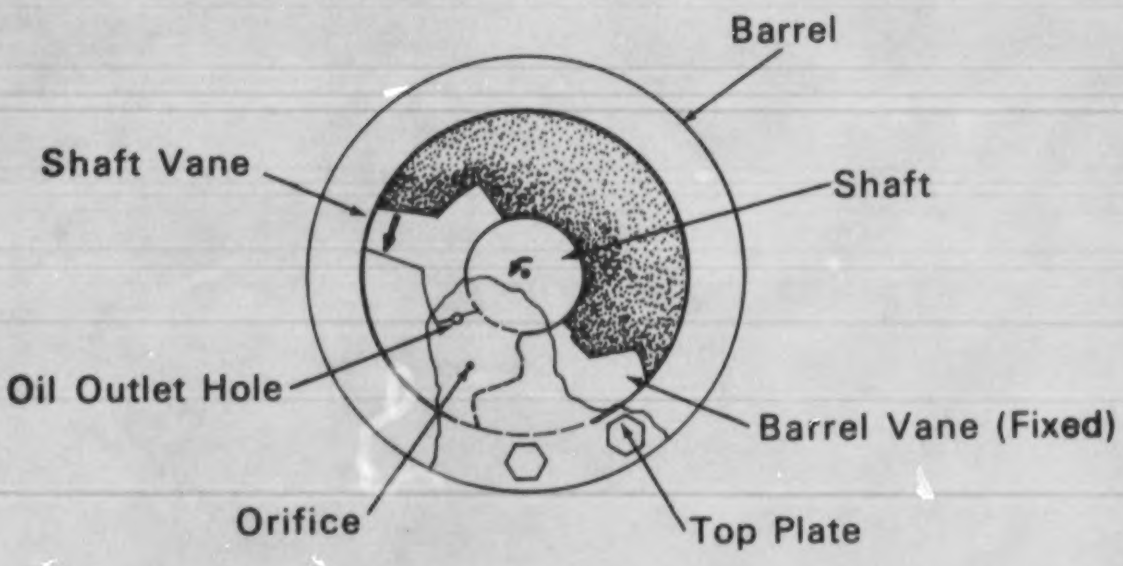


Volume Control

Classes of Hydraulic Cylinders

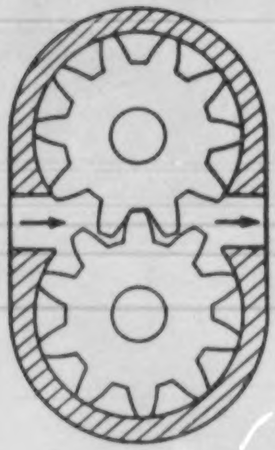


Piston Type Cylinder

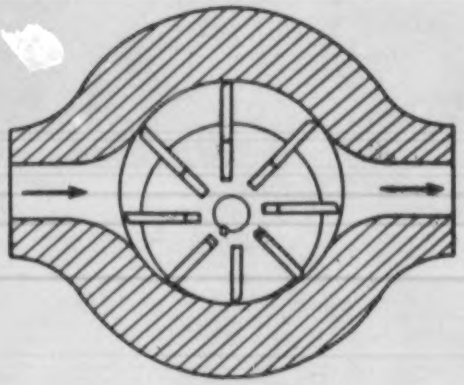

Barrel
Shaft Vane
Shaft
Oil Outlet Hole
Barrel Vane (Fixed)
Orifice
Top Plate

Vane Type Cylinder

Types of Hydraulic Motors

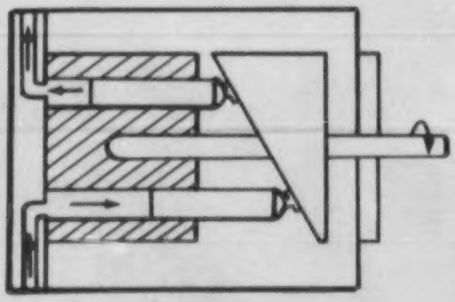


Gear

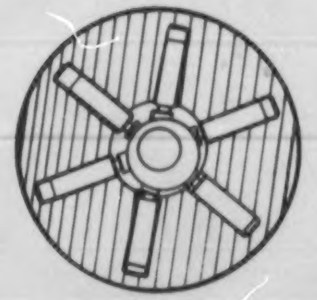


Vane

Piston

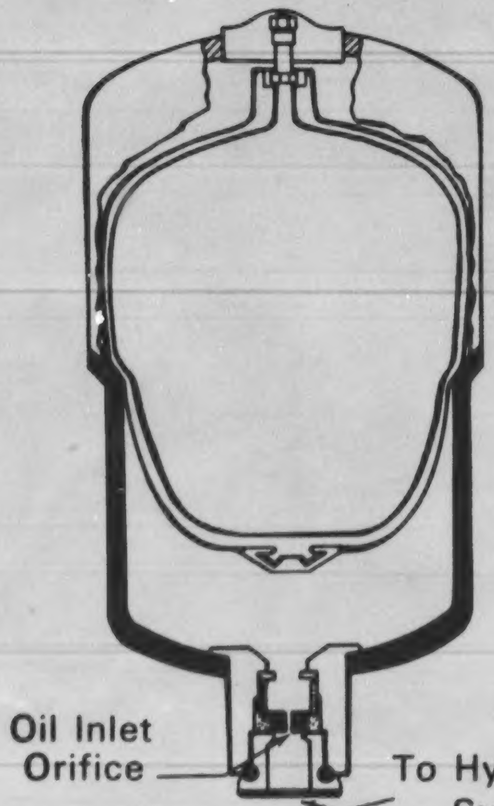


Axial

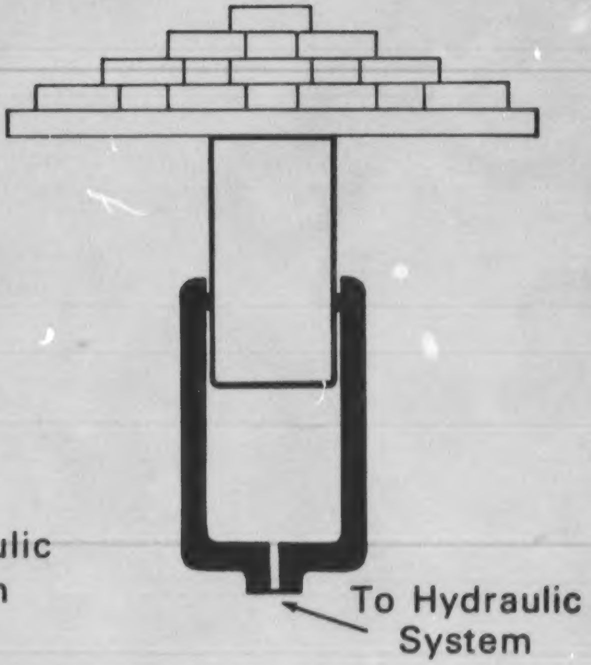


Radial

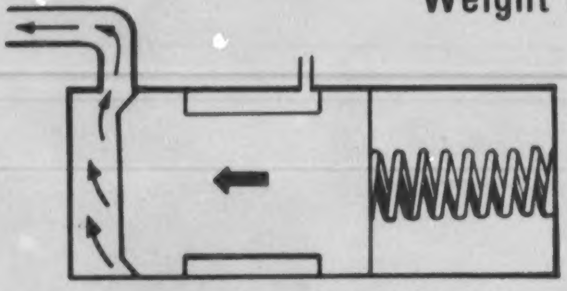
Types of Accumulators


Oil Inlet Orifice
To Hydraulic System

Pneumatic

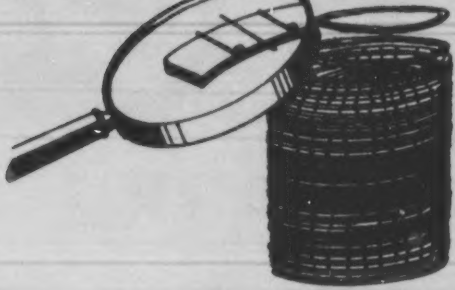

To Hydraulic System

Weight Loaded

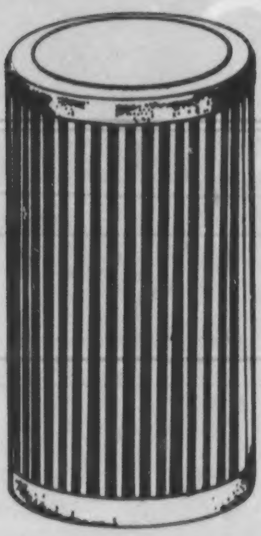


Spring Loaded

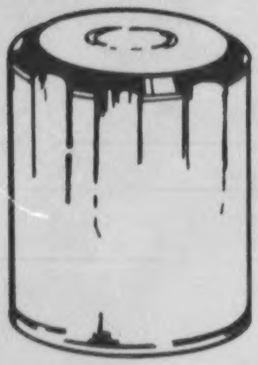
Types of Filters



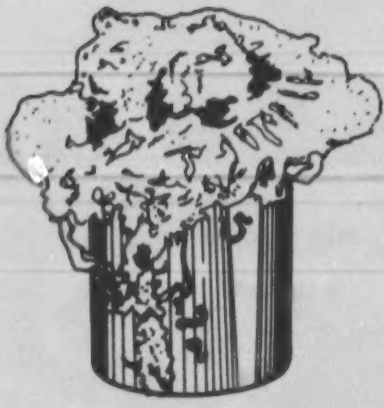
Metal Edge Filter



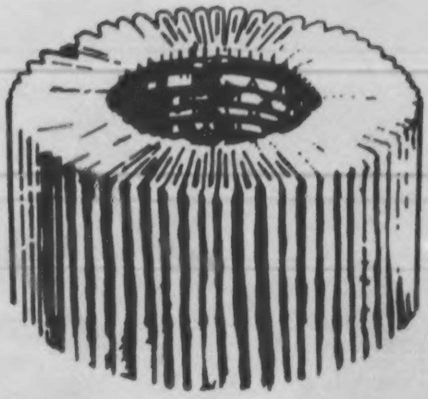
Wire Mesh Filter



Cannister

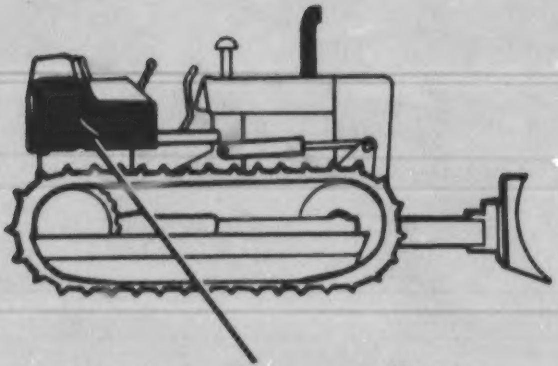


Cotton Waste Filter

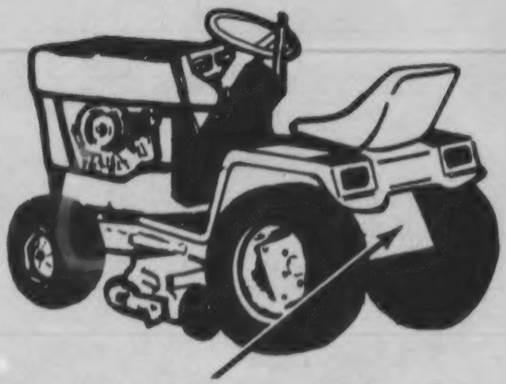


Pleated Paper Filter

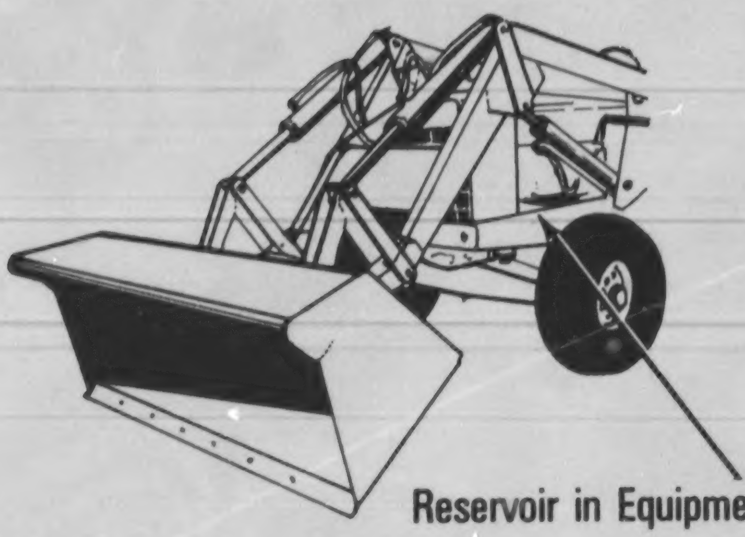
Locations of Reservoirs



Reservoir in Separate Tank

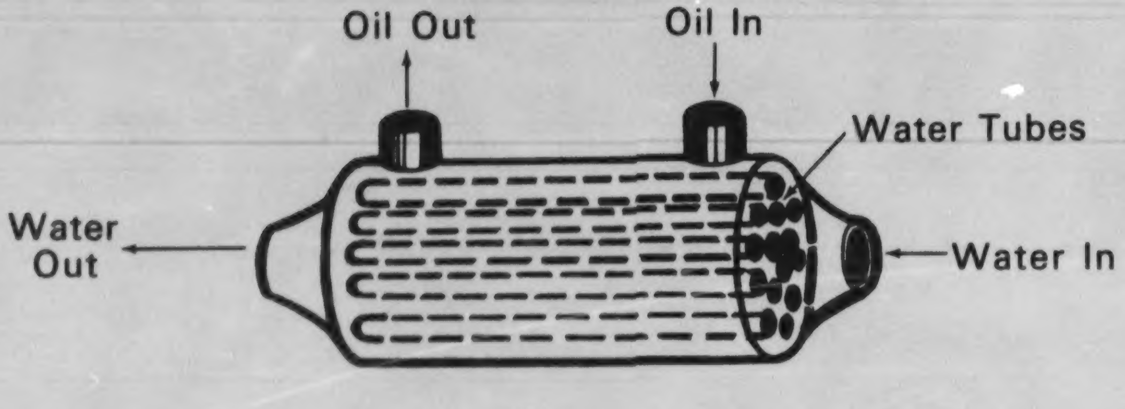


Reservoir in Transmission Case

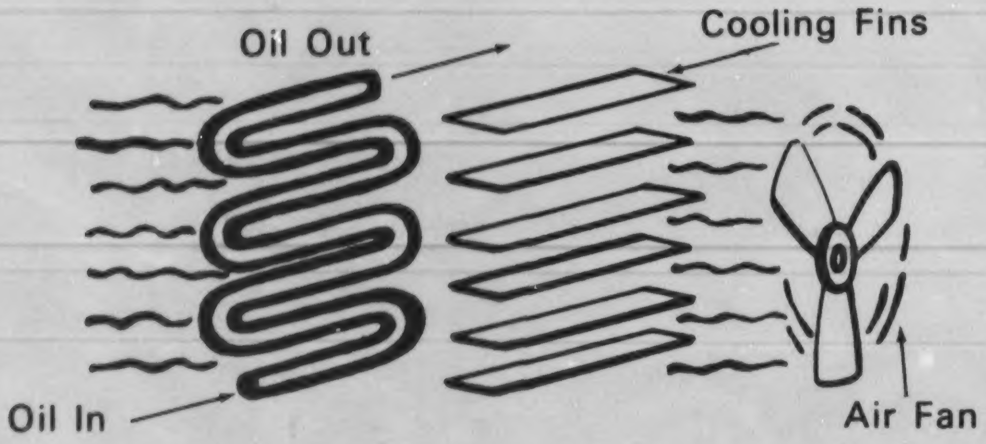


Reservoir in Equipment Frame

Types of Oil Coolers

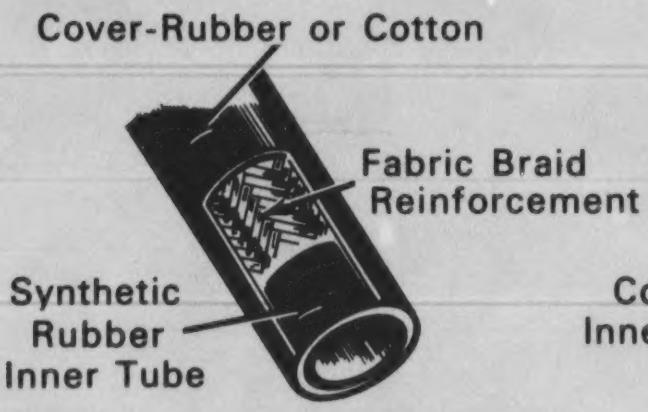

Oil Out
Oil In
Water Tubes
Water Out
Water In

Water

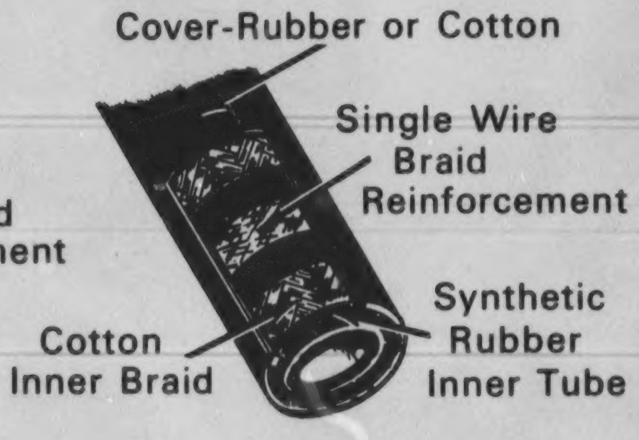

Oil Out
Cooling Fins
Oil In
Air Fan

Air

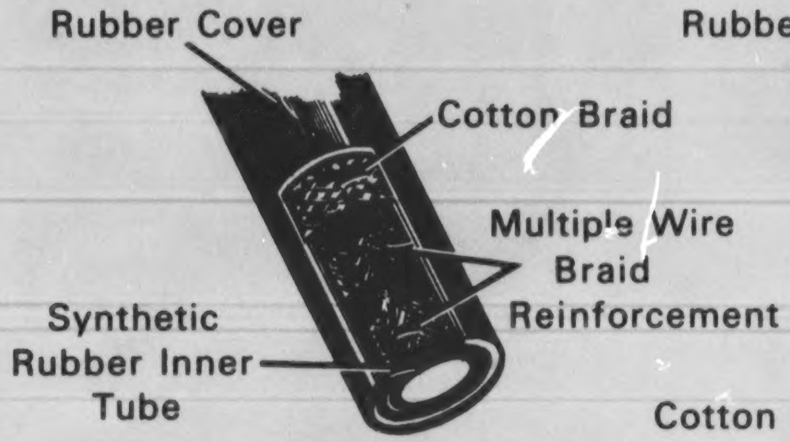
Types of Hoses


Cover-Rubber or Cotton
Fabric Braid Reinforcement
Synthetic Rubber Inner Tube

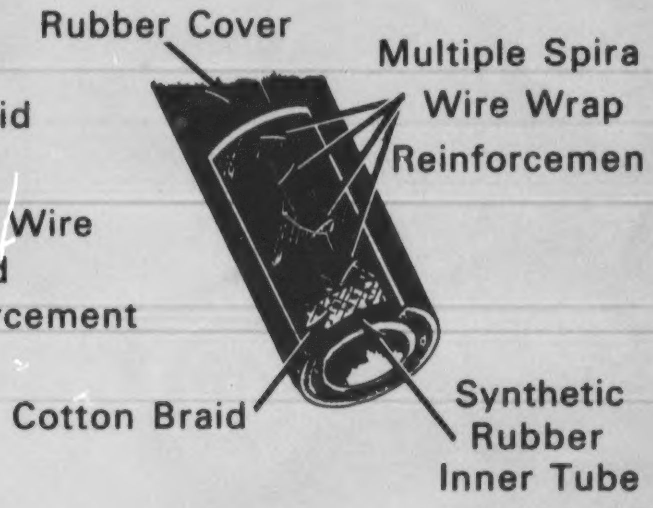
Fabric Braid Hose
(For Lower Pressures)


Cover-Rubber or Cotton
Single Wire Braid Reinforcement
Cotton Inner Braid
Synthetic Rubber Inner Tube

Single Wire Braid Hose

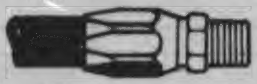

Rubber Cover
Cotton Braid
Multiple Wire Braid Reinforcement
Synthetic Rubber Inner Tube

Double Wire Braid Hose

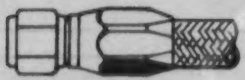

Rubber Cover
Multiple Spira Wire Wrap Reinforcemen
Cotton Braid
Synthetic Rubber Inner Tube

Spiral Wire Hose

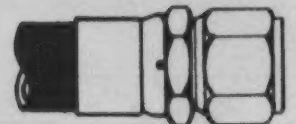
Fittings



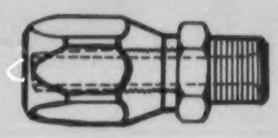
Male Coupler



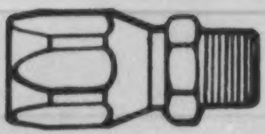
Female Coupler



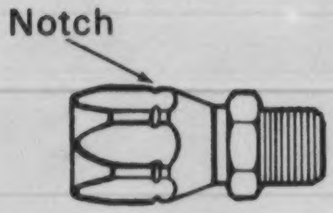
Permanent



Reusable

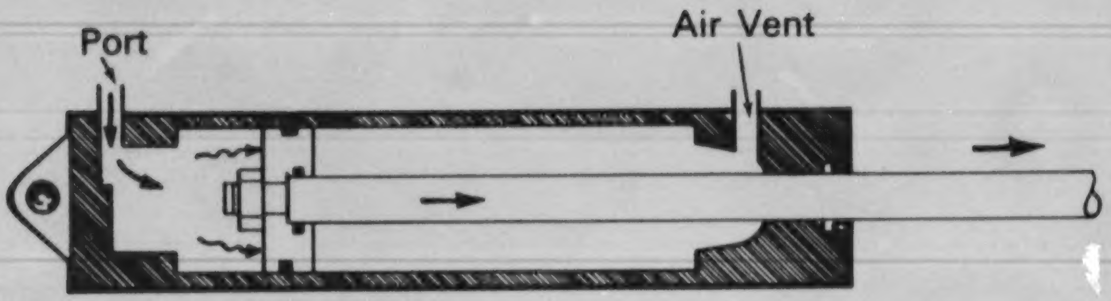


Medium Pressure

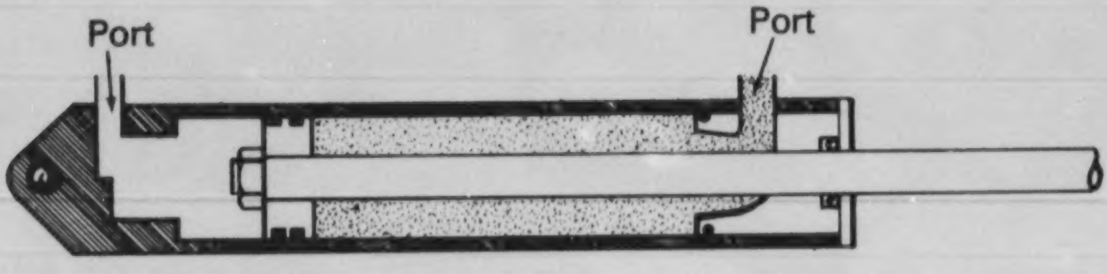


High Pressure (Notched)

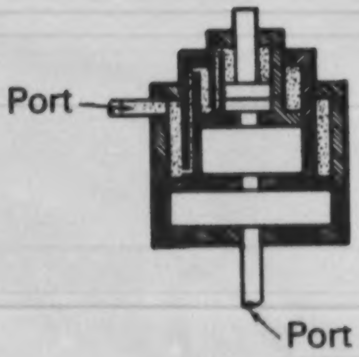
Types of Hydraulic Cylinders


Port
Air Vent

Single Acting



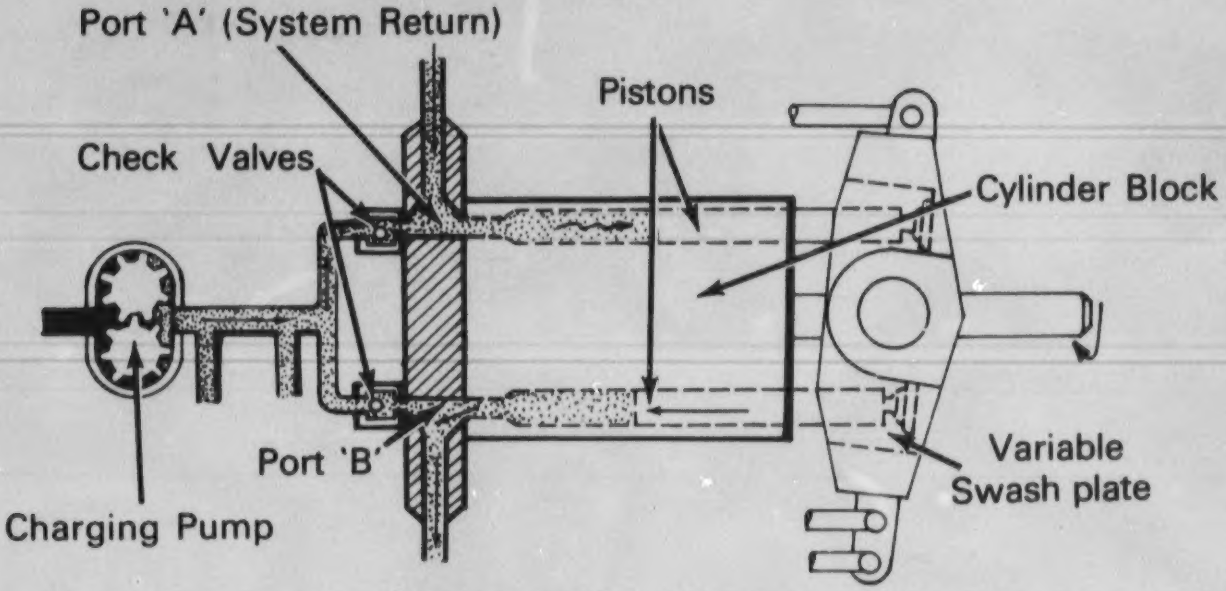
Double Acting



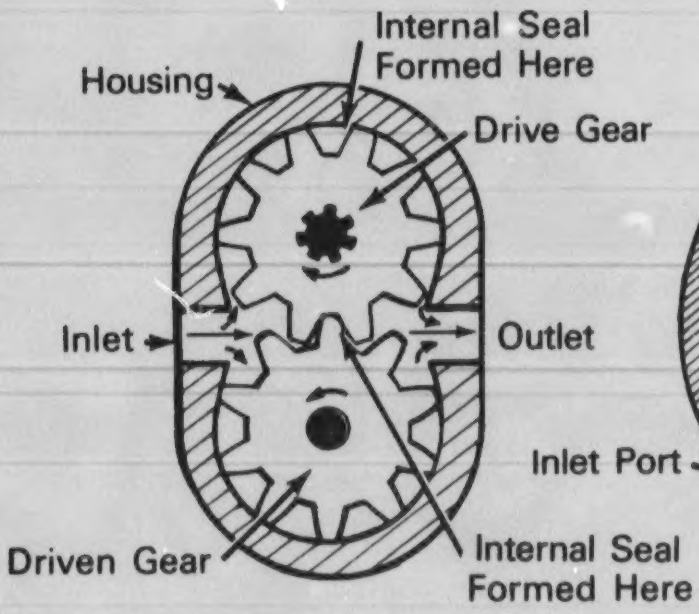
Telescoping

C1

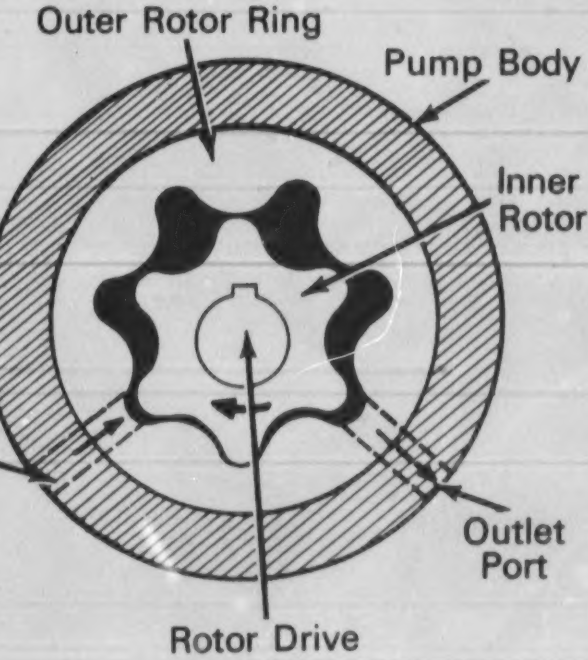
Parts of Hydraulic Pumps


Port 'A' (System Return)
Pistons
Check Valves
Cylinder Block
Port 'B'
Variable Swash plate
Charging Pump

Axial Piston Pump


Internal Seal Formed Here
Housing
Drive Gear
Inlet
Outlet
Driven Gear
Internal Seal Formed Here

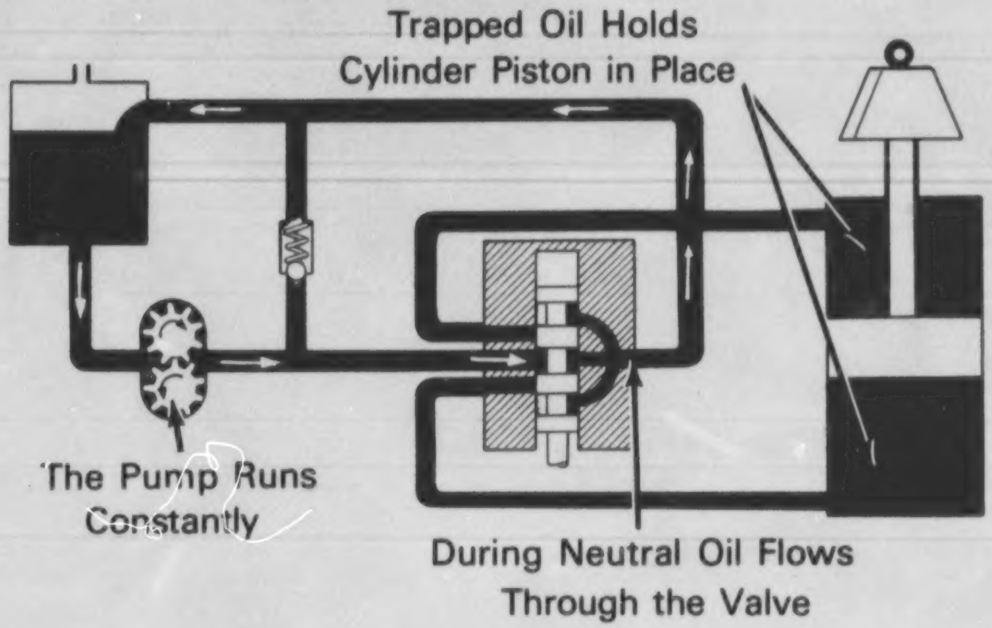
External Gear Pump


Outer Rotor Ring
Pump Body
Inner Rotor
Inlet Port
Outlet Port
Rotor Drive

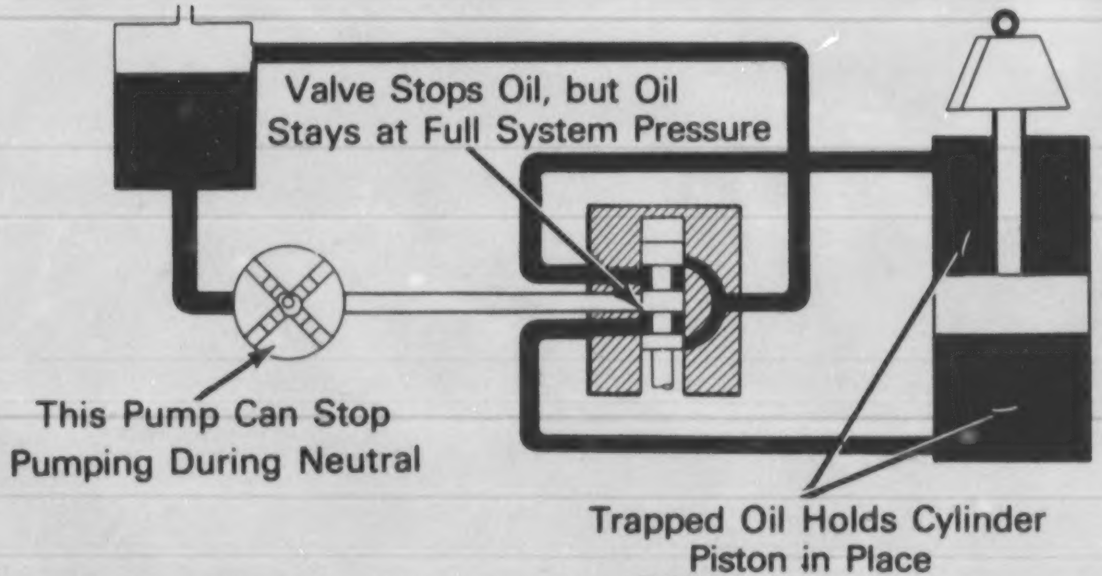
Internal Gear Pump

Open and Closed Center Systems

Opened Center System in Neutral


Trapped Oil Holds
Cylinder Piston in Place
The Pump Runs
Constantly
During Neutral Oil Flows
Through the Valve

Closed Center System in Neutral


Valve Stops Oil, but Oil
Stays at Full System Pressure
This Pump Can Stop
Pumping During Neutral
Trapped Oil Holds Cylinder
Piston in Place

HYDRAULIC SYSTEM
UNIT II

NAME ______________________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. Transfers fluids but will not build pressure

_____b. Transfers fluids and will back up fluids causing pressure

_____c. Pump which has a constant volume of flow

_____d. Pump which is capable of varying volume to equalize pressure

_____e. Resistance to flow in a hydraulic system

_____f. Device which controls either pressure of fluid, direction of fluid flow, or rate of flow

_____g. System with control valve(s) which are open to continuous hydraulic flow, even in neutral position

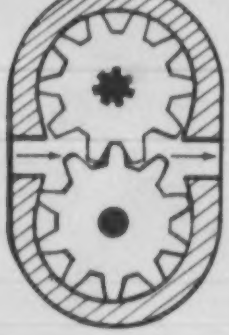
_____h. System with control valve(s) which are closed during neutral position, stopping fluid flow

_____i. Reservoir for storing hydraulic fluid under pressure

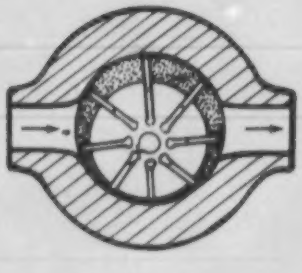
_____j. Device which provides automatic control of large amounts of power while using a small amount of power

1. Hydraulic pressure
2. Closed center system
3. Nonpositive displacement pump
4. Opened center system
5. Positive displacement pump
6. Variable displacement
7. Valve
8. Fixed displacement
9. Accumulator
10. Servo

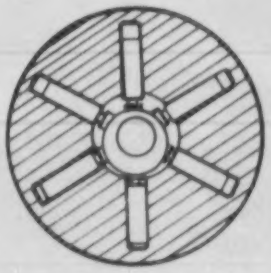
2. Identify the specific hydraulic system components.



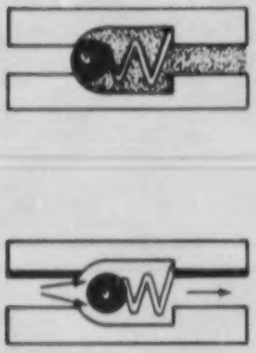
a. ____________________

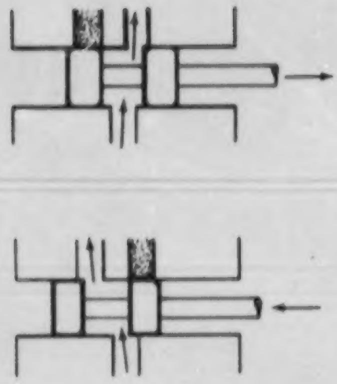


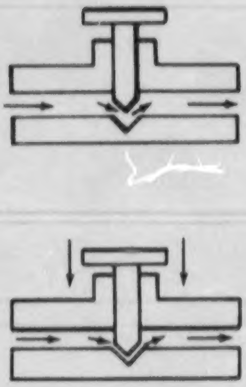
b. ____________________



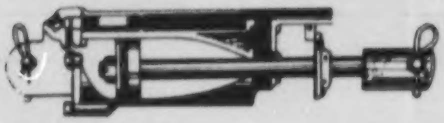
c. ____________________

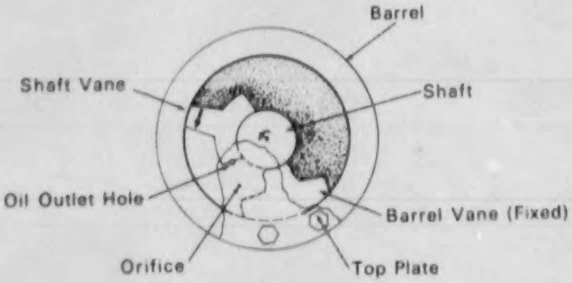




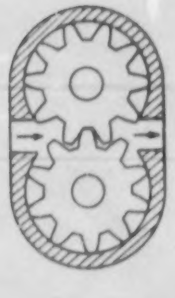


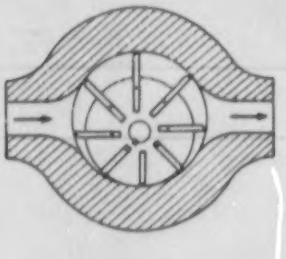
d. ______________ e. ______________ f. ______________

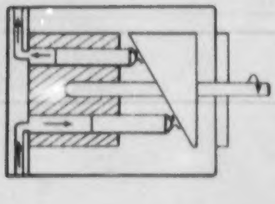



Barrel
Shaft Vane
Shaft
Oil Outlet Hole
Barrel Vane (Fixed)
Orifice
Top Plate

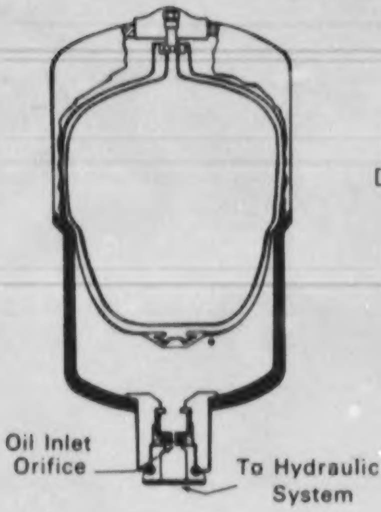
g. ______________________________ h. ______________________________

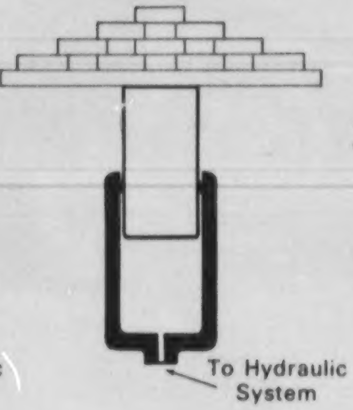


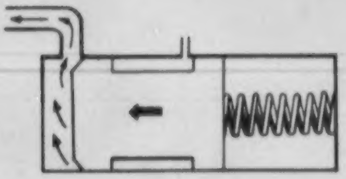




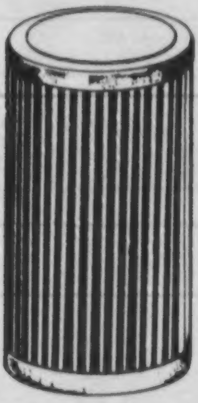
i. ______________ j. ______________ k. ______________

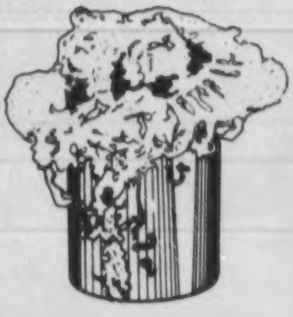

Oil Inlet Orifice
To Hydraulic System

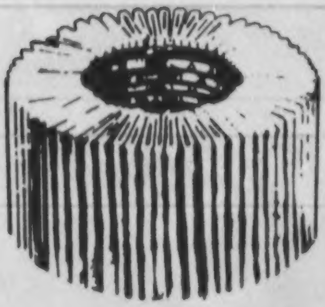

To Hydraulic System



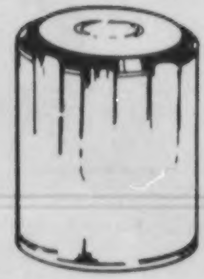
l. ____________ m. ____________ n. ____________



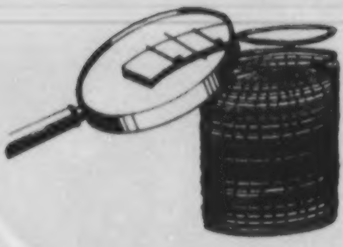


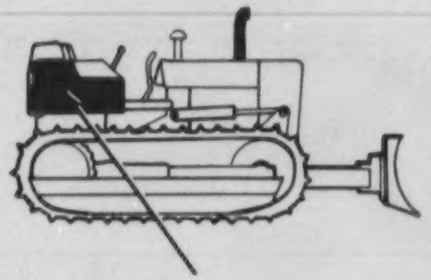


o. ____________ p. ____________ q. ____________



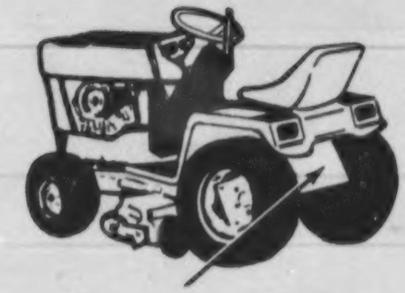
s. ________________________

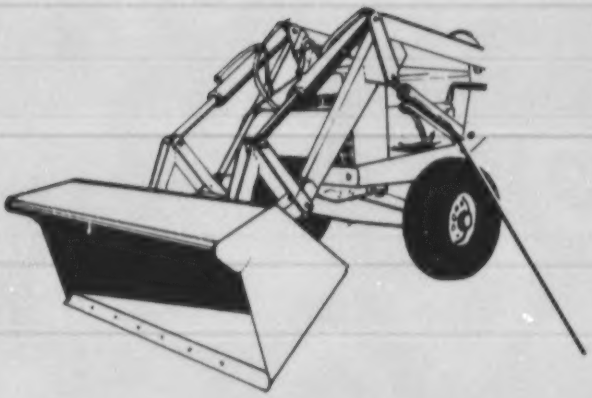




r. ________________________

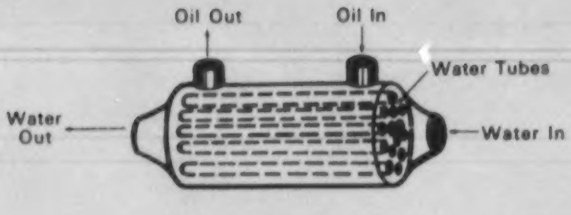
t. ________________________

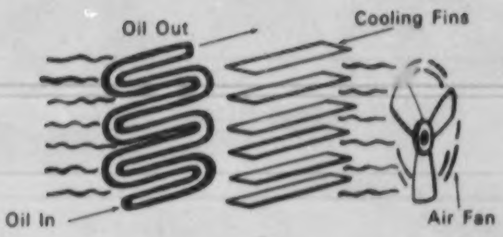




u. ________________________

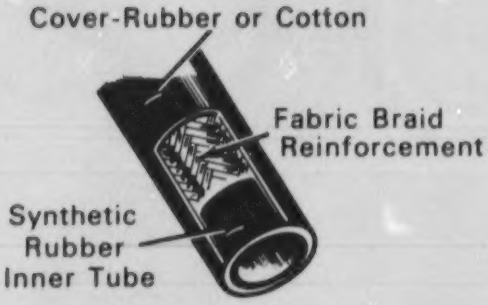
v. ________________________

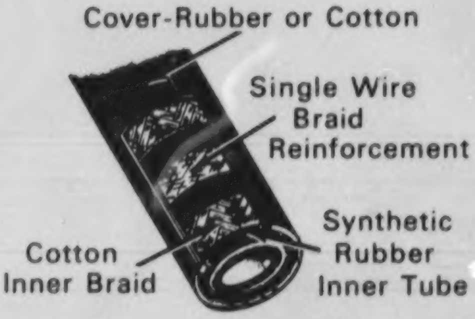

Oil Out
Oil In
Water Tubes
Water Out
Water In


Oil Out
Cooling Fins
Oil In
Air Fan

w. ____________________

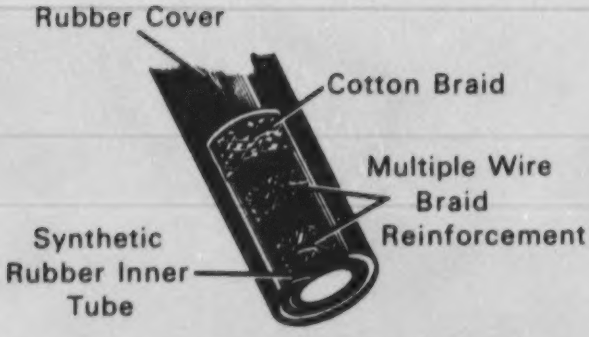
x. ____________________

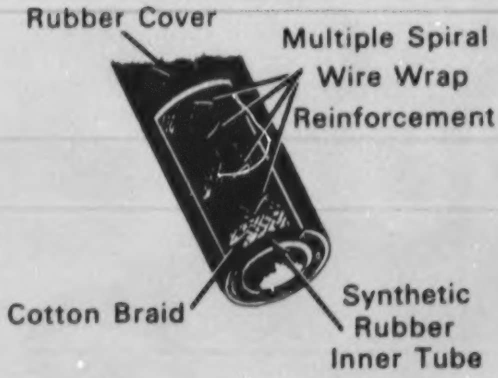

Cover-Rubber or Cotton
Fabric Braid Reinforcement
Synthetic Rubber Inner Tube


Cover-Rubber or Cotton
Single Wire Braid Reinforcement
Cotton Inner Braid
Synthetic Rubber Inner Tube

y. ____________________

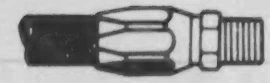
z. ____________________


Rubber Cover
Cotton Braid
Multiple Wire Braid Reinforcement
Synthetic Rubber Inner Tube

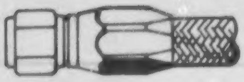

Rubber Cover
Multiple Spiral Wire Wrap Reinforcement
Cotton Braid
Synthetic Rubber Inner Tube

aa. ____________________

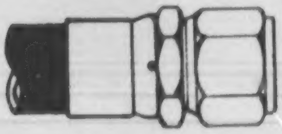
bb. ____________________



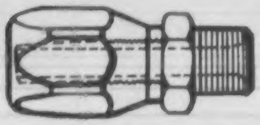
cc. ______________________________



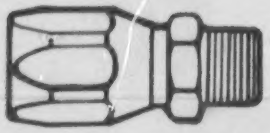
dd. ______________________________



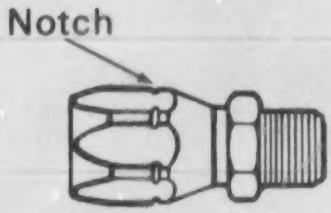
ee. ______________________________



ff. ______________________________

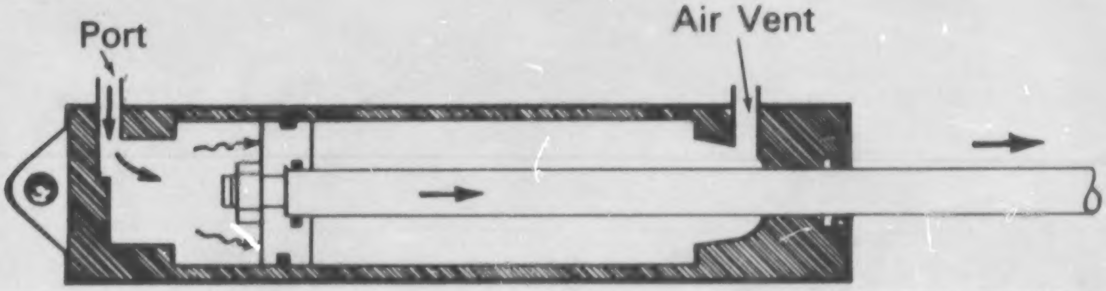


gg. ______________________________



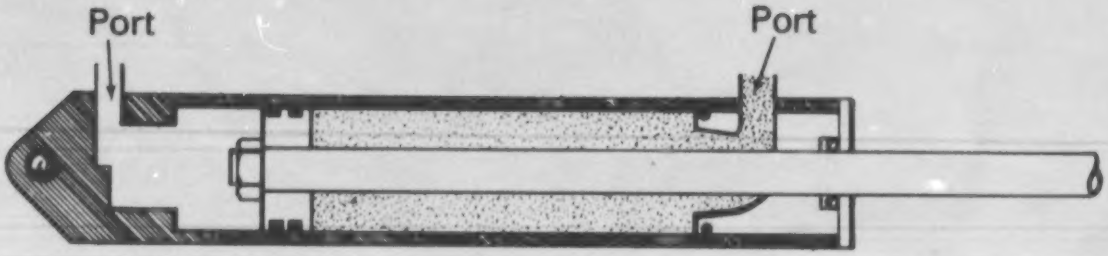
hh. ______________________________

3. Identify the types of hydraulic cylinders.

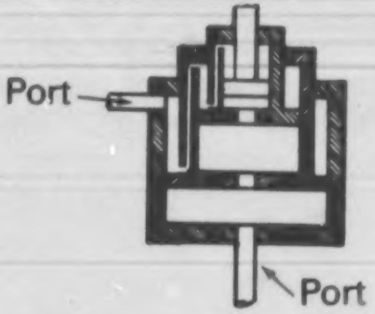


Port
Air Vent

a. ____________ ____________________

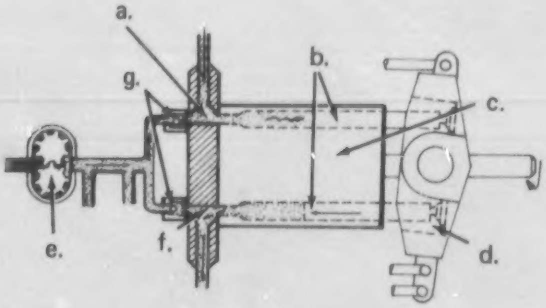


b. ______________________________



c. ______________________________

4. Identify the parts of the hydraulic pumps.



Axial Piston Pump

a. ______________________

b. ______________________

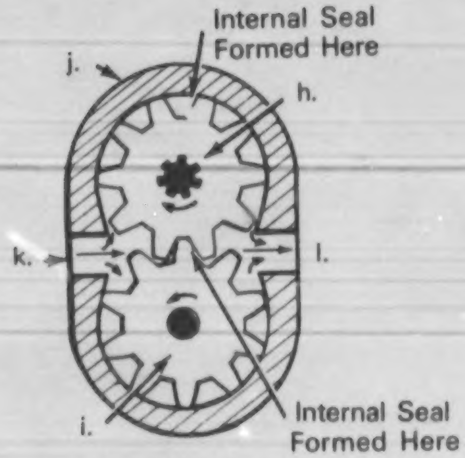
c. ______________________

d. ______________________

e. ______________________

f. ______________________

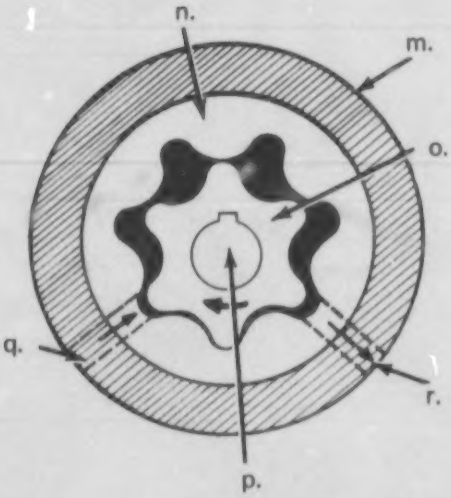
g. ______________________


Internal Seal Formed Here
j.
h.
k.
l.
i.
Internal Seal Formed Here

External Gear Pump

h. ____________ j. ____________ l. ____________

i. ____________ k. ____________



Internal Gear Pump

m. ____________ o. ____________ q. ____________

n. ____________ p. ____________ r. ____________

5. Match the types of valves on the right to their functions.

_____a. 1) Limit system pressure
 2) Reduce pressures
 3) Determine pressure for circuit

_____b. Determines or limits fluid direction in a circuit

_____c. 1) Control volume of fluid in circuit
 2) Divide fluid into other circuit paths

1. Directional control valves
2. Flow control valves
3. Pressure control valves

6. Distinguish between opened and closed center system characteristics by placing an "o" next to the characteristics of an opened center system.

_____a. Pressure is varied, flow is constant

_____b. Control valve dead ends pump in neutral

_____c. Works best with variable displacement pump

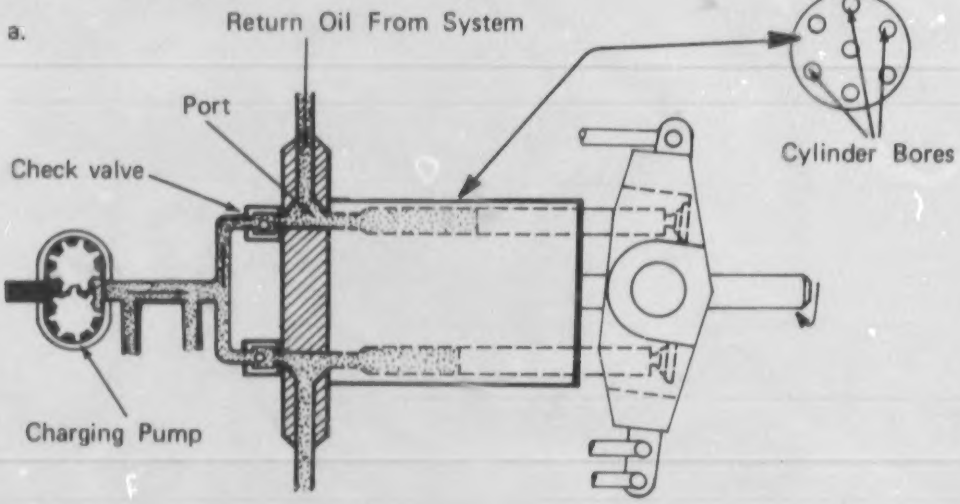
_____d. Works with constant flow pumps (fixed displacement)

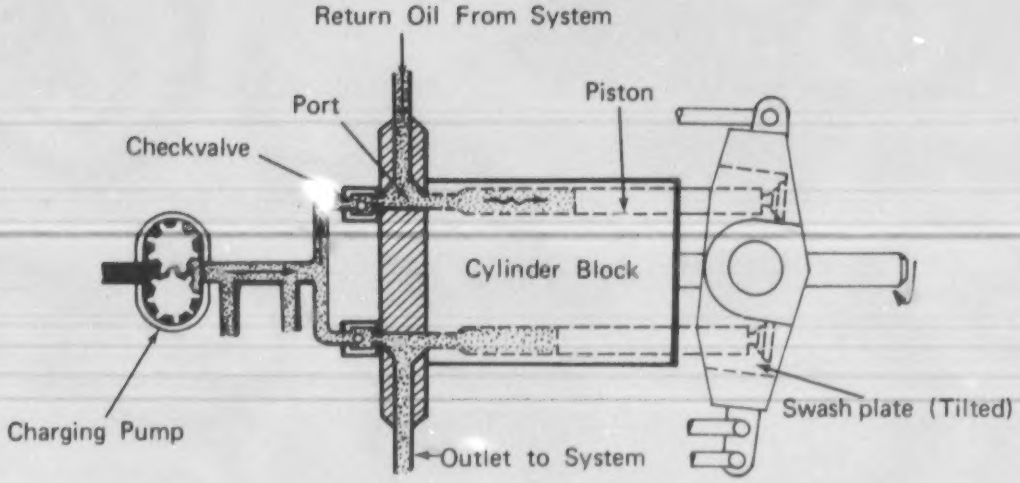
_____e. Control valve spool is open in the center to allow fluid return to reservoir in neutral

_____f. Flow varies, pressure is constant

7. Describe the fluid flow through a variable displacement axial piston pump using the given illustrations.

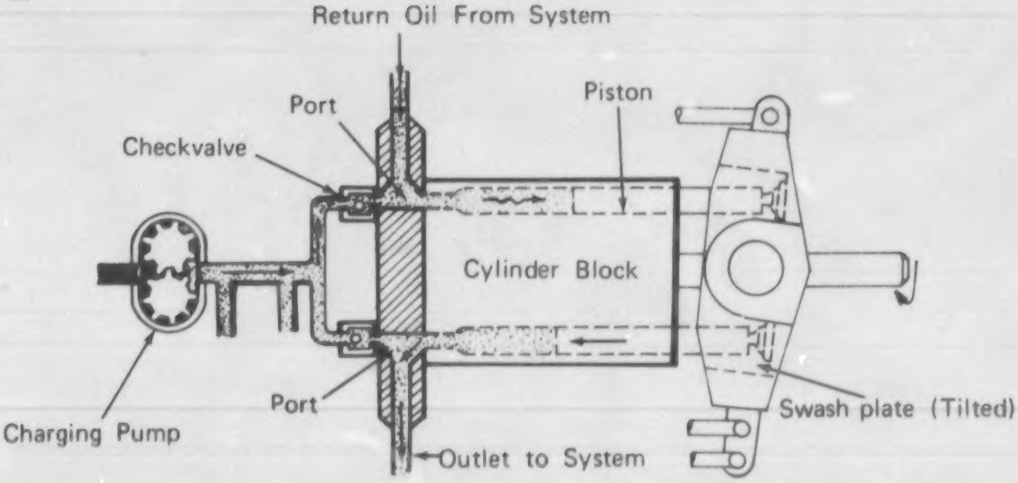
a.

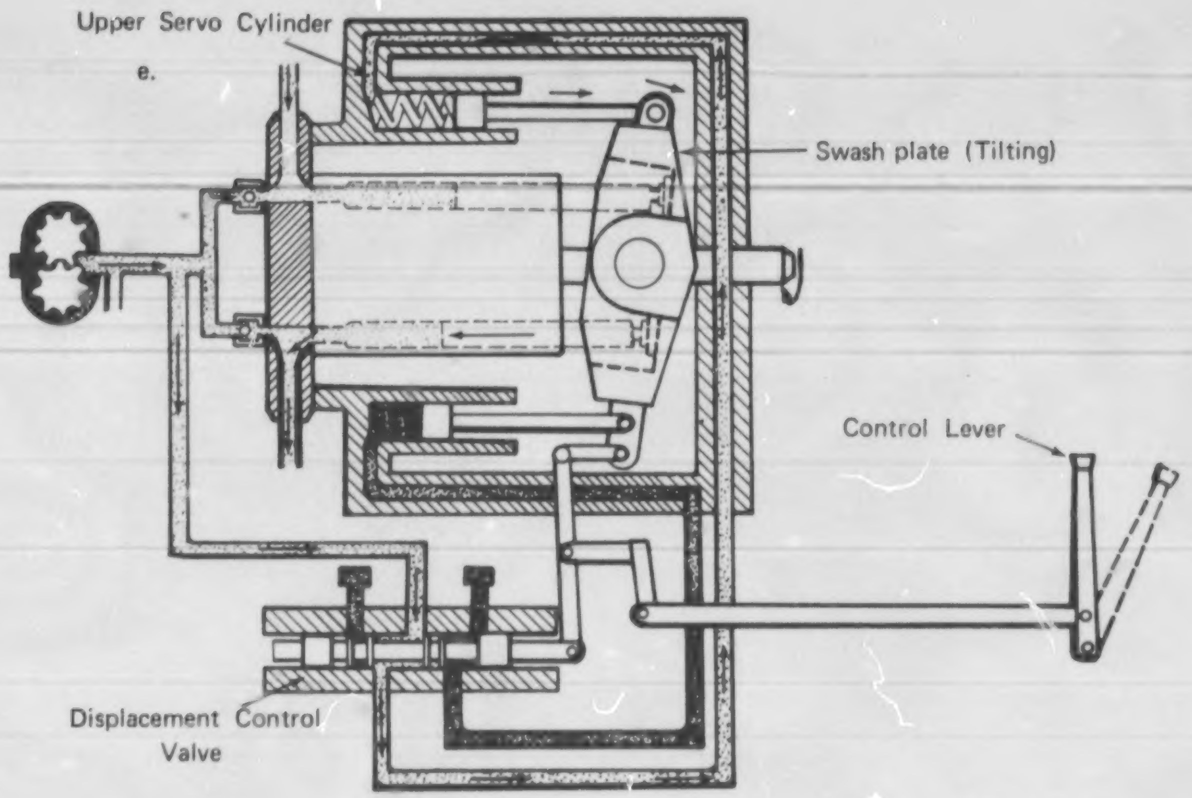



Return Oil From System
Port
Piston
Checkvalve
Cylinder Block
Charging Pump
Swash plate (Tilted)
Outlet to System

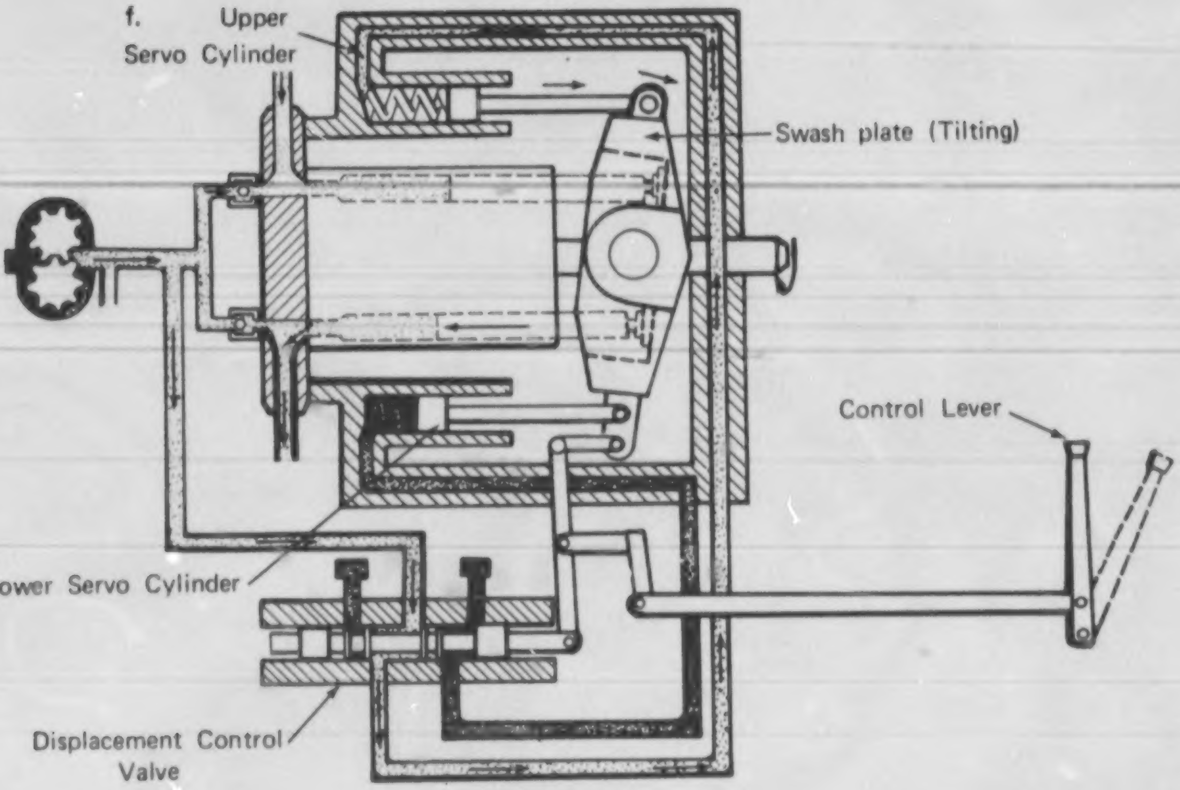
c.

d.


Return Oil From System
Port
Piston
Checkvalve
Cylinder Block
Charging Pump
Port
Swash plate (Tilted)
Outlet to System


Upper Servo Cylinder
e.
Swash plate (Tilting)
Control Lever
Displacement Control Valve

f.


Upper Servo Cylinder
Swash plate (Tilting)
Control Lever
Lower Servo Cylinder
Displacement Control Valve

HYDRAULIC SYSTEMS
UNIT II

ANSWERS TO TEST

1. a. 3
   b. 5
   c. 8
   d. 6
   e. 1
   f. 7
   g. 4
   h. 2
   i. 9
   j. 10

2. a. Gear pump
   b. Vane pump
   c. Radial piston pump
   d. Pressure control valve
   e. Directional control valve
   f. Volume control valve
   g. Piston type cylinder
   h. Vane type cylinder
   i. Gear hydraulic motor
   j. Vane hydraulic motor
   k. Axial piston hydraulic motor
   l. Pneumatic accumulator
   m. Weight loaded accumulator
   n. Spring loaded accumulator
   o. Wire mesh filter
   p. Cotton waste filter
   q. Pleated paper filter
   r. Metal edge filter
   s. Cannister filter
   t. Reservoir in separate tank

u. Reservoir in transmission case
v. Reservoir in equipment frame
w. Water oil cooler
x. Air oil cooler
y. Fabric braid hose
z. Single wire braid hose
aa. Double wire braid hose
bb. Spiral wire hose
cc. Male coupler fitting
dd. Female coupler fitting
ee. Permanent fitting
ff. Reusable fitting
gg. Medium pressure fitting
hh. High pressure (notched) fitting

3. a. Single acting hydraulic cylinder
b. Double acting hydraulic cylinder
c. Telescoping hydraulic cylinder

4. a. Port A (system return)
b. Pistons
c. Cylinder block
d. Variable swash plate
e. Charging pump
f. Port B
g. Check valves
h. Drive gear
i. Driven gear
j. Housing
k. Inlet port

l. Outlet port

m. Pump body

n. Outer rotor ring

o. Inner rotor

p. Rotor drive

q. Inlet port

r. Outlet port

5. a. 3

b. 1

c. 2

6. a, d, e

7. Discussion should include:

a. Charging pump pulls oil from reservoir and forces it through a check valve where it mixes with return oil at inlet port

b. As the cylinder rotates the piston bores align with the port and the charging pressure forces the pistons back against the swash plate

c. As the cylinder block continues to rotate, pressure develops as the pistons compress against the fluid due to the angle of the swash plate

d. When the piston bores align with the outlet port the fluid is forced under pressure into the system

e. When the control lever is pulled to the left it pulls the displacement control valve to the left allowing fluid to flow to the upper servo cylinder

f. The upper servo tilts the swash plate which forces fluid from the lower servo

g. When the control lever is released the displacement control valve returns to neutral, trapping the oil in the servos and locking the swash plate angle

MAINTAINING THE HYDRAULIC SYSTEM
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms and system problems to their correct definitions or corrective procedures. The student should also be able to demonstrate the ability to change the fluid in a hydraulic system. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with maintaining the hydraulic system to the correct definitions.
2. Identify test equipment.
3. Match four types of hydraulic system problems to possible corrective procedures.
4. Select steps that should be taken before a customer picks up equipment.
5. Demonstrate the ability to change fluid in a hydraulic system.

MAINTAINING THE HYDRAULIC SYSTEM
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Make transparency.

  D. Discuss unit and specific objectives.

  E. Discuss information and job sheets.

  F. Show students examples of test equipment.

  G. Show students examples of troubleshooting charts.

  H. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet

  C. Complete job sheet.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency master #1--Hydraulic System Testing Equipment

  D. Job sheet #1--Change the Fluid in a Hydraulic System

  E. Test

  F. Answers to test

II. References:

A. *Hydraulics: Hydraulic Systems for Tractors and Other Mobil Equipment, Care and Operation Vol. 2.* Athens, Georgia: AAVIM, 1974.

B. *FOS Hydraulics.* Moline, Illinois: Deere and Company, 1972.

MAINTAINING THE HYDRAULIC SYSTEM
UNIT III

INFORMATION SHEET

I. Terms and definitions

   A. Filter--System component designed to collect contaminants in a hydraulic circuit

   B. Linkage--Mechanical parts used to connect hydraulic components, and/or transfer their power

   C. Maintenance record--Log of all routine or special maintenance performed on a specific piece of equipment

   D. System suction side--That part of the circuit where fluid is pulled back into the system or up to a pump

   E. System pressure side--That part of the circuit starting at the pressuring pump(s) and ending at the first line functioning as a system suction line

II. Test equipment (Transparency 1)

   A. System tester

   (NOTE: This type equipment comes in many designs with many options and can perform single tests or multitests simultaneously.)

   B. Pressure gauge

   (NOTE: These are generally installed in a line to test output or operating pressures.)

   C. Thermometer

   (NOTE: The system should be operated for 10-15 minutes before temperature is taken. Systems generally operate at less than 200° F.)

III. System problems and corrective procedures

(CAUTION: Block up working units if you must work on the system while raised. Never depend on the hydraulic lift.)

   A. Fluid leaks

   (NOTE: Leaks can cause improper equipment operation or equipment damage if not repaired and are unsightly as they collect dust and dirt.)

INFORMATION SHEET

1. Check fluid level in reservoir

   (NOTE: This check is generally conducted with cylinders retracted.)

2. Check all external lines and fittings for leaks

   (NOTE: There are usually many visual signs such as dirt accumulation or oil spray on adjoining parts.)

3. Inspect cylinders for leaks

   (NOTE: Cylinder leaks will generally occur due to ram damage or seal deterioration.)

B. Air leaks

(NOTE: Low fluid or suction side leaks can allow air to enter the system.)

1. Evaluate the system during operation

   (NOTE: Air in the system generally causes spongy response and slow and weak hydraulic effort. Chattering noises can also signal air in the system.)

2. Check fluid in reservoir

   (NOTE: Low fluid level can indicate possible entrance of air; foamy oil indicates air has entered the system.)

3. Check suction line if exposed

   (NOTE: If the leak cannot be heard you can spray oil over the line and watch its reaction. If drawn into the line a leak exists.)

C. System overheating

1. Check fluid temperature

   (NOTE: System must be brought up to operating temperature before this test can be made.)

2. Check for overload

   (NOTE: Improper use of equipment and poor maintenance are the two leading causes of overheating.)

IMFORMATION SHEET

3. Check fluid

    (NOTE: Check the level, color, and smell of the fluid. It is always possible that someone could have added the wrong type of fluid.)

4. Check filter

5. Check for mechanical binds

6. Check cooling equipment

    (NOTE: A clogged radiator or damaged or clogged fins will cause problems in equipment systems.)

D. Mechanical trouble

1. Look for nonsystem related interference

    (NOTE: A block of wood trapped between mechanical surfaces, tie down straps used in transporting that were not removed, and any number of other things can cause mechanical interference.)

2. Check for binding or broken linkages

    (NOTE: Defective parts can cause a bind which causes an excessive load.)

3. Check for hose binding

    (NOTE: A hose can get pinched between mechanical surfaces.)

4. Check for bent or damaged piston rams

    (NOTE: The cylinder will have to be extended for this test. A square or any straight edge can be placed along the ram.)

IV. Steps that should be taken before a customer picks up equipment

A. Update maintenance record

(NOTE: If a record is kept you should register the day and description of maintenance performed.)

B. Be sure system components are cleaned

(NOTE: Remove dirt from around filler plugs, breathers and vents.)

C. Make a visual inspection of all mechanical parts

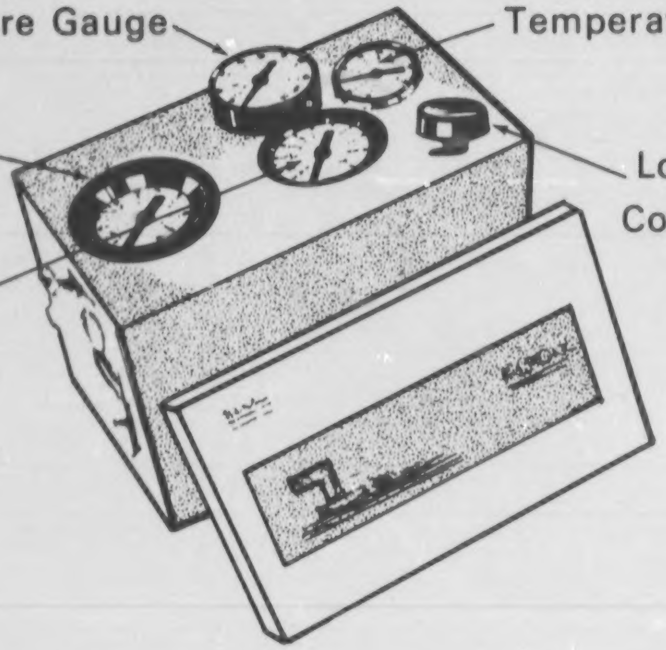
INFORMATION SHEET

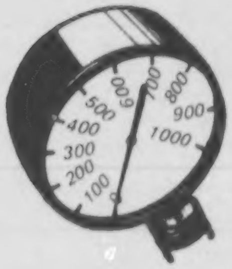
D. Check fluid level

(NOTE: Remove air from the system.)

E. Demonstrate that the system is operative to the customer

Hydraulic System Testing Equipment


Low Pressure Gauge
Temperature Gauge
Flow Meter
Load Valve Control Knob
High Pressure Gauge


0
100
200
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400
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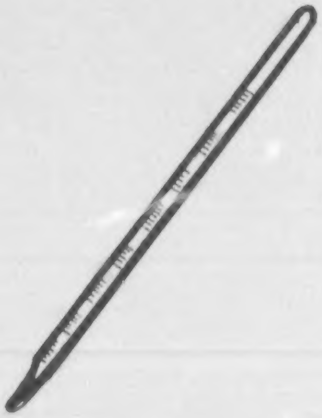
600
700
800
900
1000



System Tester

Thermometer

Pressure Gauge

MAINTAINING THE HYDRAULIC SYSTEM
UNIT III

JOB SHEET #1--CHANGE FLUID IN A HYDRAULIC SYSTEM

I. Tools and materials

- A. Safety glasses
- B. Hand tool assortment
- C. Shop towels
- D. Oil pan
- E. Appropriate hydraulic fluid

  (NOTE: Check owners manual or equipment nameplate for proper fluid.)

- F. Funnel or other suitable fluid pouring device
- G. Appropriate filter

II. Procedure

- A. Gather tools and equipment
- B. Start engine and bring fluids up to operating temperature

  (NOTE: This thins the fluid so it will drain easier as well as pull contaminants into suspension so they will drain.)

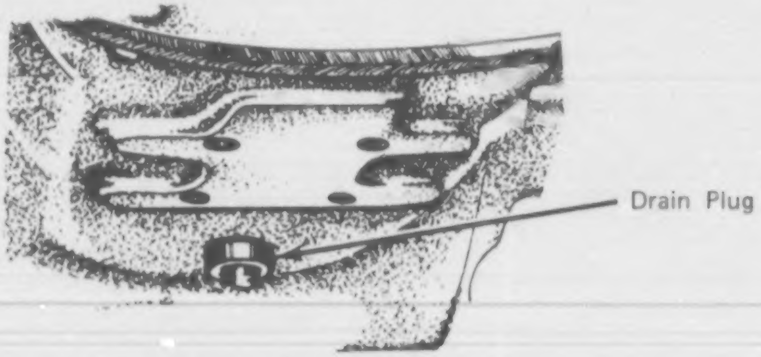
- C. Retract all cylinders

  (NOTE: This forces as much oil back into the reservoir as possible.)

- D. Turn engine off
- E. Locate drain plug (Figure 1)

  (NOTE: Sometimes there is more than one plug.)

FIGURE 1



JOB SHEET #1

F. Position drain pan under drain plug

G. Wipe around drain plug with cloth

H. Remove drain plug

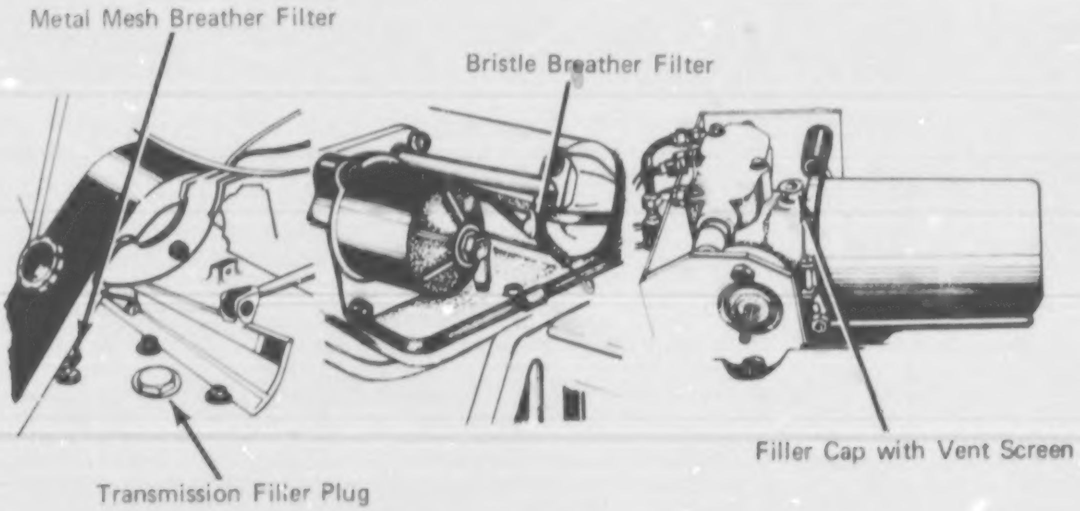
I. Service filter

(NOTE: Some systems may have disposable elements or cannister filters while others have screens. If a screen filter is used wash it in clean hydraulic fluid, not gasoline.)

J. Service ventilation filter (Figure 2)

(NOTE: Larger systems have a separate breather for the reservoir, smaller systems often have a screen in the filler cap. Wash these filters in clean hydraulic fluid.)

FIGURE 2

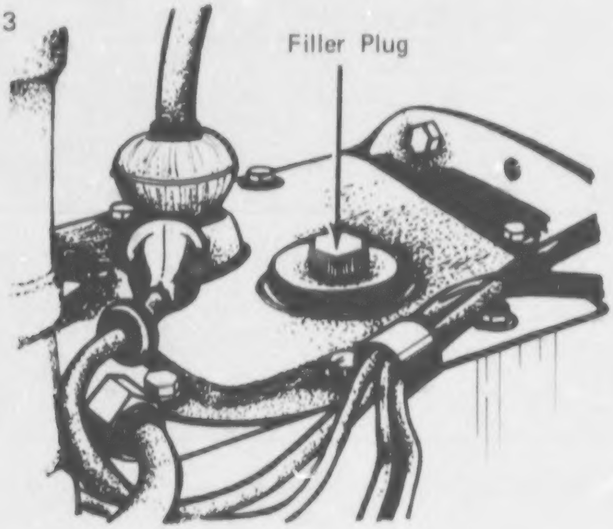

Metal Mesh Breather Filter
Bristle Breather Filter
Filler Cap with Vent Screen
Transmission Filler Plug

JOB SHEET #1

K. Clean around filler plug (Figure 3)

(NOTE: The area around the plug needs to be extremely clean to help guarantee that contaminants do not enter the system.)

FIGURE 3



L. Remove filler plug

M. Replace all filters and vents

N. Replace drain plug

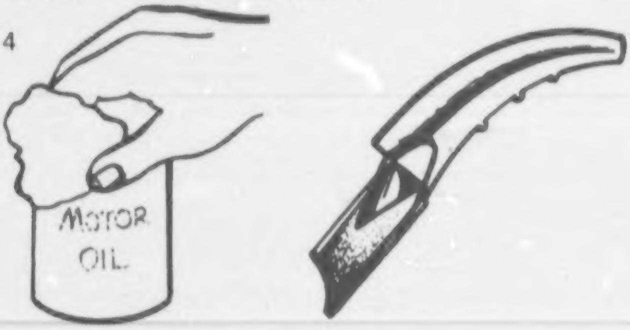
O. Move oil drain pan

(NOTE: Dispose of oil properly.)

P. Install new fluid to appropriate level

(NOTE: Make sure the tops of the oil cans, and any spouts or funnels to be used are clean. See Figure 4.)

FIGURE 4



JOB SHEET #1

Q. Replace filler cap

R. Start engine

S. Operate hydraulic systems

(NOTE: This removes air from cylinders and hoses.)

T. Retract all cylinders

U. Shut off engine

V. Recheck fluid level

W. Clean up area

X. Clean and put away tools

Y. Have instructor evaluate work

MAINTAINING THE HYDRAULIC SYSTEM
UNIT III

NAME ______________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. System component designed to collect contaminants in a hydraulic circuit

_____b. Mechanical parts used to connect hydraulic components, and/or transfer their power

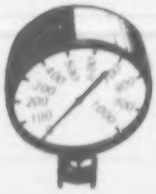
_____c. Log of all routine or special maintenance performed on a specific piece of equipment

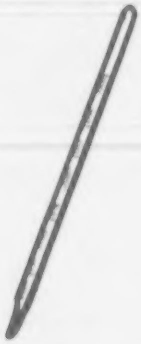
_____d. That part of the circuit where fluid is pulled back into the system or up to a pump

_____e. That part of the circuit starting at the pressuring pump(s) and ending at the first line functioning as a system suction line

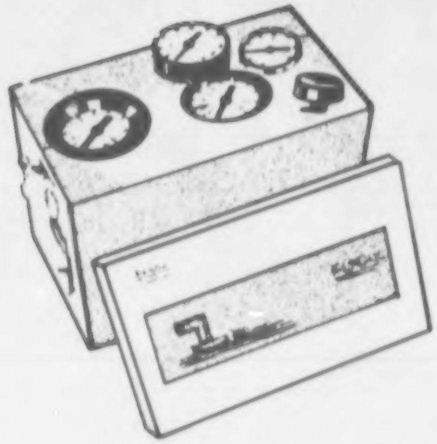
1. System suction side
2. Linkage
3. Filter
4. System pressure side
5. Maintenance record

2. Identify test equipment.





a. ______________________ b. ______________________



c. ____________________________

3. Match the types of hydraulic system problems on the right to the possible corrective procedures.

_____a. 1) Check fluid level in reservoir
    2) Check all external lines and fittings for leaks
    3) Inspect cylinders for leaks

_____b. 1) Evaluate the system during operation
    2) Check fluid in reservoir
    3) Check suction line if exposed

_____c. 1) Check fluid temperature
    2) Check for overload
    3) Check fluid
    4) Check filter
    5) Check for mechanical binds
    6) Check cooling equipment

1. Air leaks
2. Mechanical trouble
3. Fluid leaks
4. System overheating

______d. 1) Look for nonsystem related interference

2) Check for binding or broken linkages

3) Check for hose binding

4) Check for bent or damaged piston rams

4. Select steps that should be taken before a customer picks up equipment by placing an "X" in the appropriate blanks.

______a. Update maintenance record

______b. Calculate foot pounds of pressure

______c. Be sure system components are cleaned

______d. Make a visual inspection of all mechanical parts

______e. Check fluid level

______f. Reset check valve

______g. Demonstrate that the system is operative to the customer

5. Demonstrate the ability to change fluid in a hydraulic system.

MAINTAINING THE HYDRAULIC SYSTEM
UNIT III

ANSWERS TO TEST

1. a. 3
   b. 2
   c. 5
   d. 1
   e. 4
2. a. Pressure gauge
   b. Thermometer
   c. System tester
3. a. 3
   b. 1
   c. 4
   d. 2
4. a, c, d, e, g
5. Performance skills evaluated to the satisfaction of the instructor

EQUIPMENT MAINTENANCE
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify common types of lawn and garden equipment, list basic equipment maintenance procedures, sharpen a rotary mower blade, charge test a battery for three minutes, and adjust a V-belt. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with equipment maintenance to the correct definitions.
2. Identify common types of lawn and garden equipment.
3. List basic equipment maintenance procedures for lawn and garden equipment.
4. List three common battery functions.
5. Demonstrate the ability to:
    a. Sharpen a rotary mower blade.
    b. Clean and service a battery.
    c. Measure battery electrolyte with an hydrometer.
    d. Load test a battery.
    e. Charge test a battery for three minutes.
    f. Adjust a V-belt.

EQUIPMENT MAINTENANCE
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information and job sheets.

   F. Take a field trip to a large lawn and garden equipment shop.

   G. Demonstrate and discuss the procedures outlined in the job sheets.

   H. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Lawn and Garden Equipment

      2. TM 2--Lawn and Garden Equipment (Continued)

      3. TM 3--Lawn and Garden Equipment (Continued)

D. Job sheets

1. Job Sheet #1--Sharpen a Rotary Mower Blade with a File
2. Job Sheet #2--Clean and Service a Battery
3. Job Sheet #3--Measure Battery Electrolyte With an Hydrometer
4. Job Sheet #4--Load Test a Battery
5. Job Sheet #5--Charge Test a Battery for Three Minutes
6. Job Sheet #6--Adjust a V-belt

E. Test

F. Answers to test

II. References:

A. Foutes, William. *Diesel Engine Mechanics*. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, 1978.

B. Wantiez, Gary. *Air Conditioning and Refrigeration, Book Two*. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, 1977.

EQUIPMENT MAINTENANCE
UNIT I

INFORMATION SHEET

I. Terms and definitions

   A. Lawn and garden equipment--All equipment designed to maintain a lawn or garden

   B. Accessory--Equipment designed as an optional component part

   C. Maintenance--Routine service procedures necessary to keep equipment operating safely and efficiently

   D. Pneumatic--Relating to air or air pressure

   E. Blade balancer--Equipment designed to detect an uneven distribution of weight from the center mounting hole to the blade tips

   F. Battery--Two or more connected cells which convert chemical energy into electrical energy

   G. Cell--One negative and one positive plate group

   H. Electrolyte--Solution of water and sulphuric acid

   I. Specific gravity--Weight of liquid compared to an equal volume of water at 60° F

   J. Hydrometer--Glass barrel syringe containing a calibrated float used to measure specific gravity

II. Types of lawn and garden equipment (Transparencies 1, 2, and 3)

   A. Mowers

      1. Rotary

      2. Rotary self propelled

      3. Lawn and garden tractor accessory

      4. Reel

   B. Tillers

      1. Walk behind

      2. Tractor accessory

INFORMATION SHEET

C. Sprayers

  1. Unit

  2. Tractor accessory

D. Snow blowers

  1. Walk behind unit

  2. Tractor accessory

E. Lawn vacuums

F. Shredders

G. Edger-trimmer

III. Basic equipment maintenance procedures for lawn and garden equipment

A. Keep all belts properly adjusted and clean

B. Maintain proper tension on chains

C. Lubricate moving parts according to manufacturer's specifications

D. Service engines according to manufacturer's specifications

E. Keep all blades balanced and cutting edges sharp

F. Maintain proper inflation on all pneumatic tires

(NOTE: Most inflatable lawn and garden equipment tires use a relatively low pressure Be sure and check rating before inflating.)

G. Service batteries according to manufacturer's specifications

IV. Battery functions

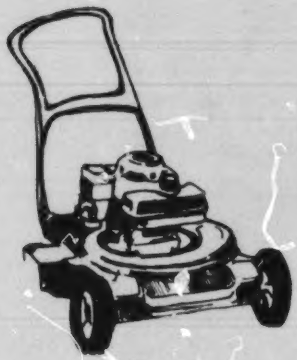
A. Supply current for cranking engine

B. Provides current to meet demands above charging output

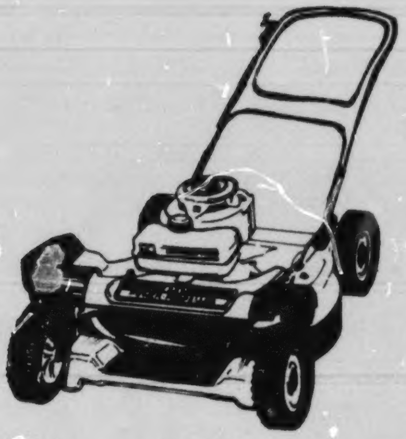
C. Stabilize system voltage

Lawn and Garden Equipment

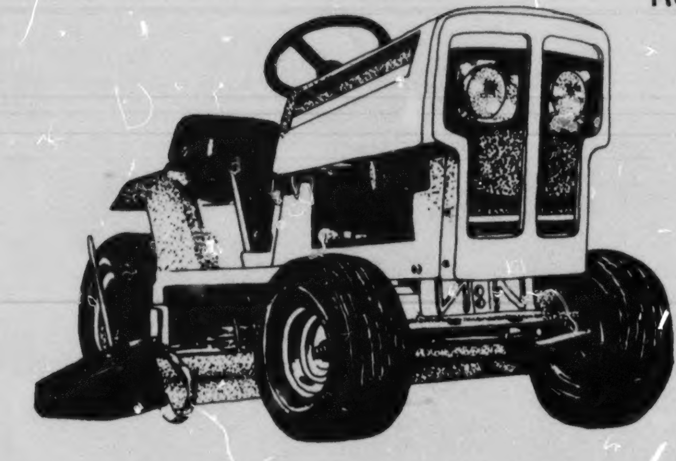
Mowers



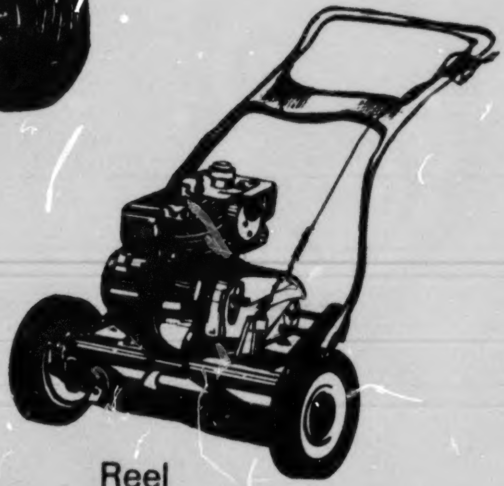
Rotary



Rotary Self-Propelled



Lawn and Garden
Tractor Accessory

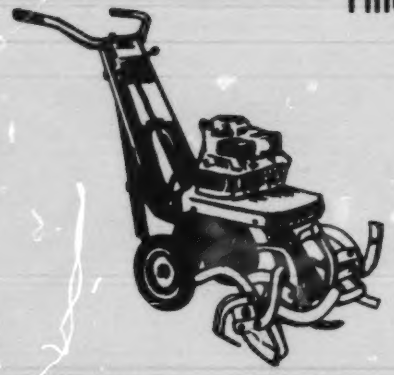


Reel

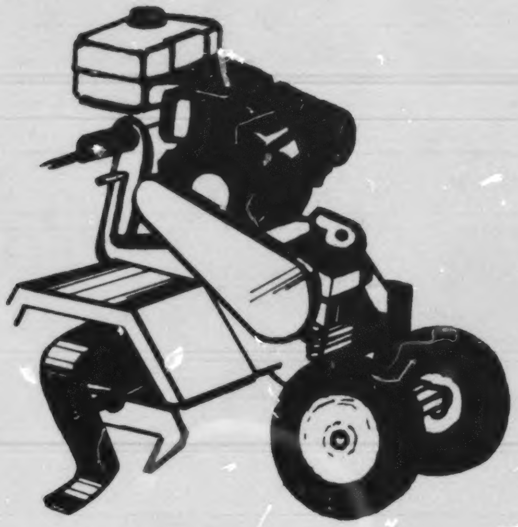
Lawn and Garden Equipment

(Continued)

Tillers

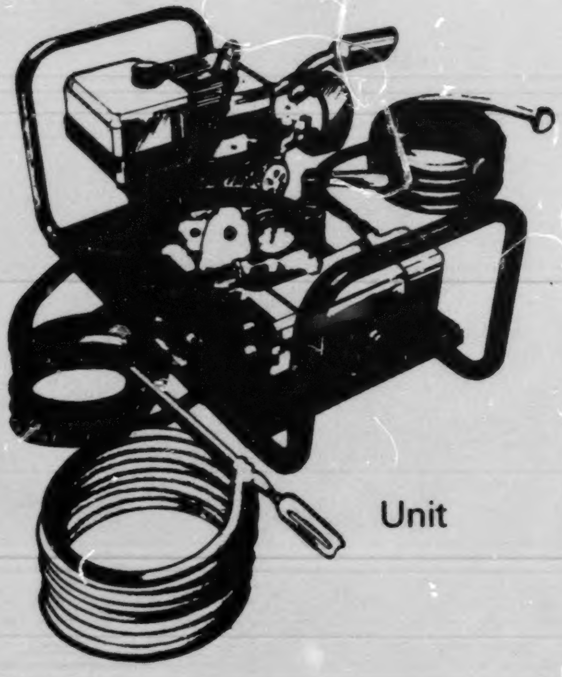


Walk Behind

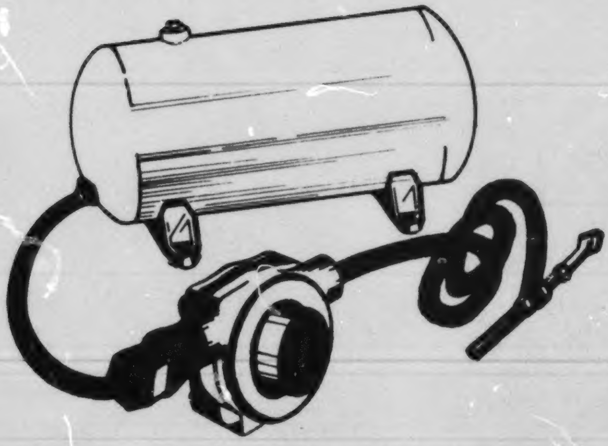


Tractor Accessory

Sprayers



Unit

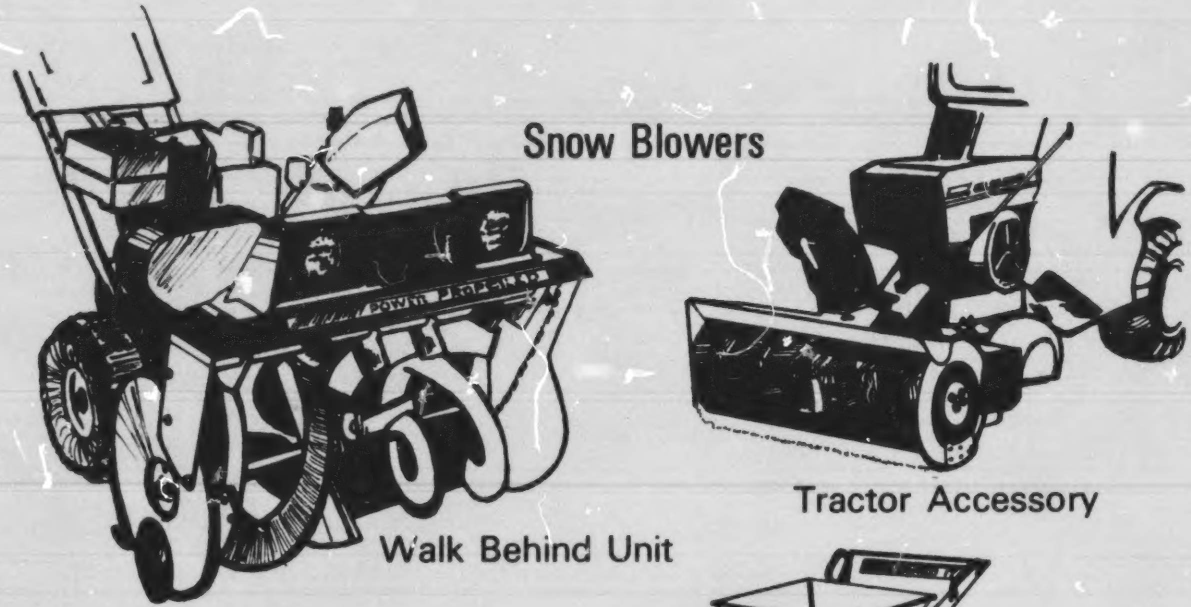


Tractor Accessory

Lawn and Garden Equipment

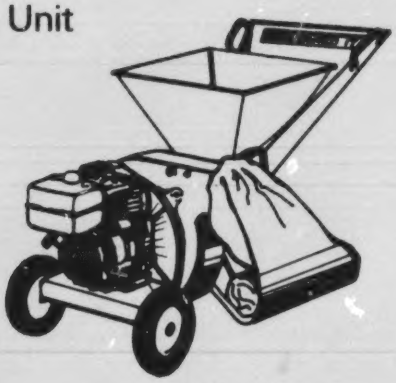
(Continued)

Snow Blowers

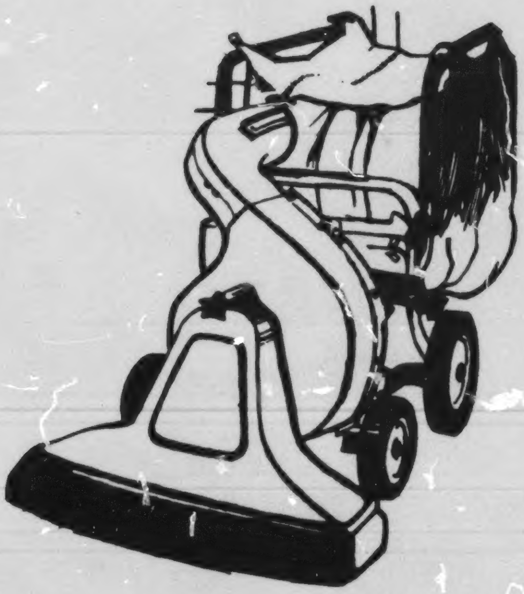


Walk Behind Unit

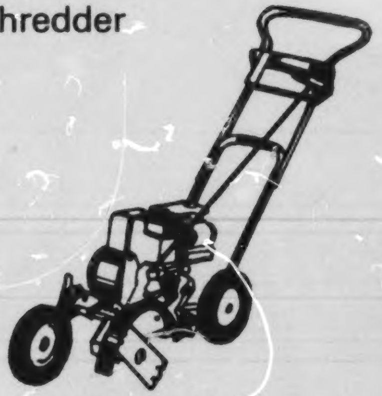
Tractor Accessory



Shredder



Lawn Vacuum



Edger-Trimmer

EQUIPMENT MAINTENANCE
UNIT I

JOB SHEET #1--SHARPEN A ROTARY MOWER BLADE

I. Tools and materials

A. Safety glasses

B. Hand tool assortment

C. Large flat file with handle

D. Vise

E. Blade balancer

F. Framing square

G. Shop towels

H. Grinder

I. Face shield

II. Procedures

(NOTE: Be sure and remove spark plug wire from plug and ground it to the block before removing blade.)

A. Gather tools and equipment

B. Remove blade from mower

(NOTE: Be sure and place all spacers and washers together in the order of removal for ease in reassembly.)

C. Clean blade

(NOTE: Remove any built up grease or clippings that will effect the balancing to be done later.)

D. Check for cracks or chips

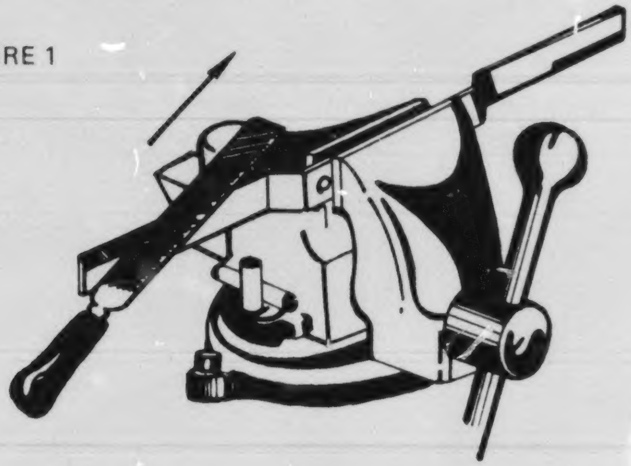
(NOTE: If blade has cracks or large pieces chipped off replace with new blade.)

E. Hand sharpen a blade with a file

JOB SHEET #1

1. File at approximately 45° angle to blade (Figure 1)

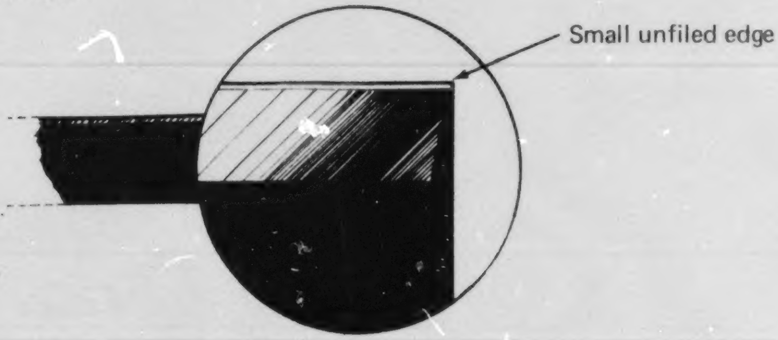
FIGURE 1



(NOTE: Only push a file, and always lift it off the blade on the back stroke.)

2. Continue filing until cutting surface is clean and only a small even blunt edge exists (Figure 2)

FIGURE 2



(NOTE: If the blade is sharpened to a point the sharp edge easily rolls over and can chip off.)

3. Turn blade over and sharpen other cutting edge

(NOTE: Never file the back side of a blade.)

JOB SHEET #1

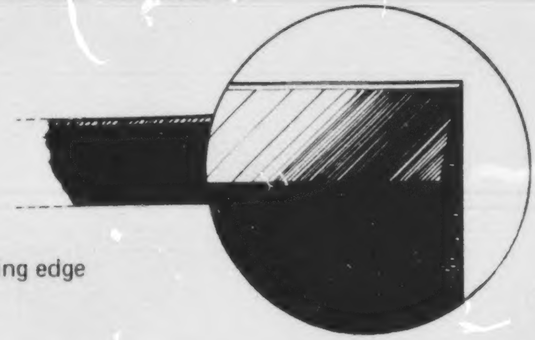
F. Sharpen a blade with a grinder

1. Put on face shield
2. Put all grinder guards and shields in the correct location
3. Dress grinder wheel
4. Adjust tool rest to match existing contour off sharpened portion of blade
5. Turn on grinder
6. Gently slide blade cutting edge along wheel surface

   (NOTE: Do not push hard on blade, and keep a bucket of water handy to keep blade cool while sharpening.)

7. Continue till small blunt edge is left (Figure 3)

FIGURE 3



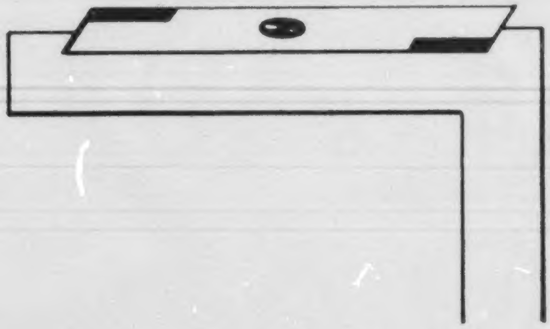
8. Sharpen other cutting edge
9. Turn off grinder

G. Check blade for straightness

(NOTE: There are magnetic holders and gauges designed for this job; you can however use a framing square as described below.)

1. Place blade on edge of framing square (Figure 4)

FIGURE 4



JOB SHEET #1

2. Check between blade and edge of square for warpage

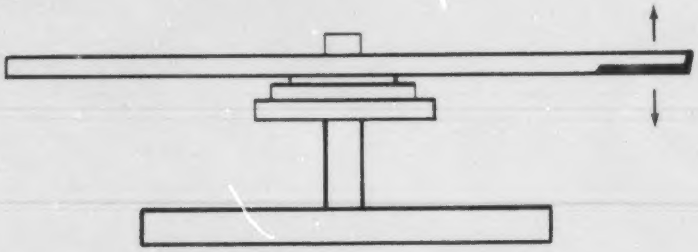
3. Straighten blade if necessary

   (NOTE: Do not hit blade with a tempered hammer. Place blade in vise and apply pressure to straighten it.)

H. Check blade balance

1. Place blade on balancer (Figure 5)

FIGURE 5



2. File cutting edge on lowest end of blade until blade sits level

   (NOTE: Be sure and maintain small blunt edge.)

I. Have instructor evaluate work

J. Replace blade on mower

EQUIPMENT MAINTENANCE
UNIT I

JOB SHEET #2--CLEAN AND SERVICE A BATTERY

I. Tools and materials

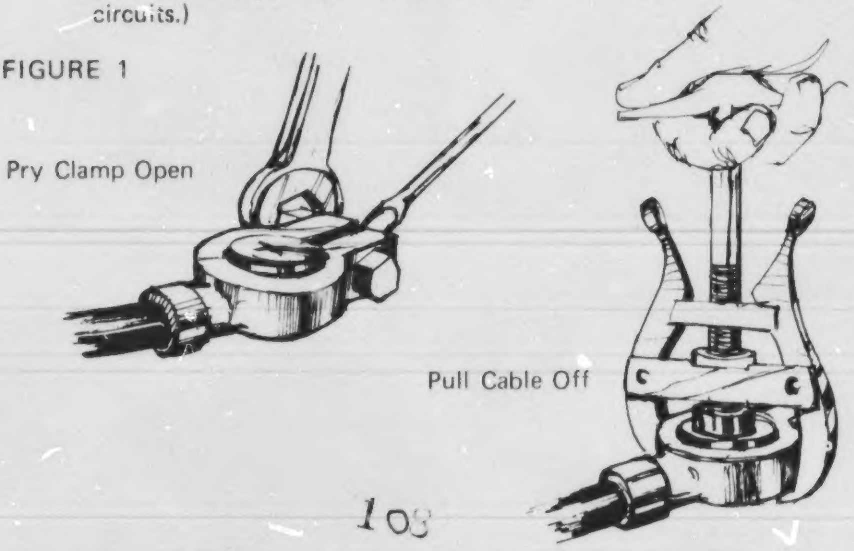
- A. Safety glasses
- B. Rubber gloves
- C. Rubber apron
- D. Bristle brush
- E. Wire brush
- F. Screwdriver
- G. Battery clamp puller
- H. Combination end wrenches
- I. Battery pliers
- J. Baking soda and water solution (two tablespoons of baking soda to one pint of water)
- K. Battery anti-corrosion paste
- L. Shop towels

II. Procedure

- A. Disconnect battery cables from the battery posts (Figure 1)

  (NOTE: Always disconnect the grounded battery cable first to avoid short circuits.)

FIGURE 1

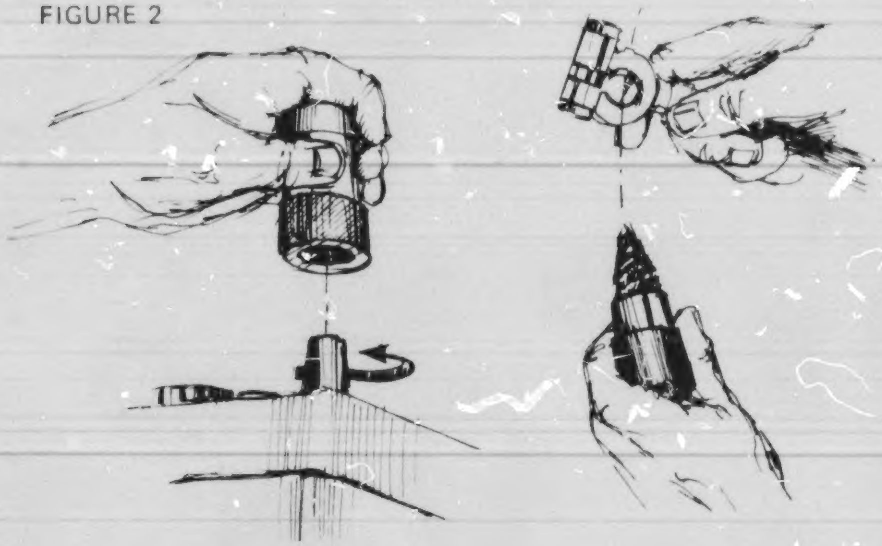


JOB SHEET #2

B. Clean battery cable clamps and battery post (Figure 2)

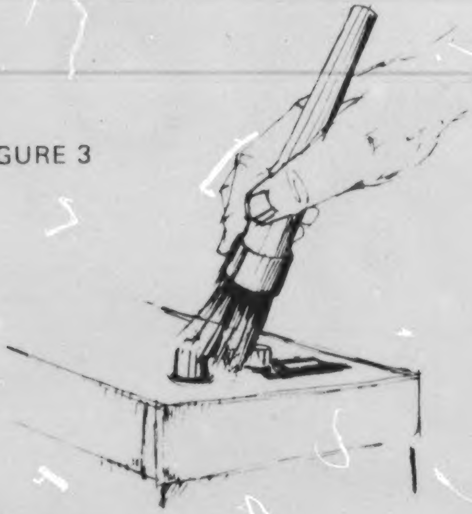
(NOTE: Battery posts and inside of battery cable clamps must be clean and bright.)

FIGURE 2



C. Remove loose dirt and corrosion particles from top of battery (Figure 3)

FIGURE 3

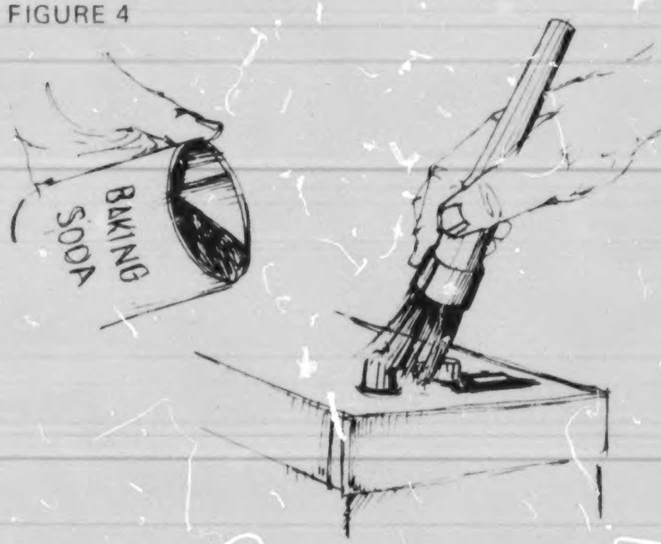


JOB SHEET #2

D. Brush soda water solution on battery, battery post, clamps, and battery hold-down (Figure 4)

(NOTE: Keep water and soda from entering the battery through the vent holes in the vent caps.)

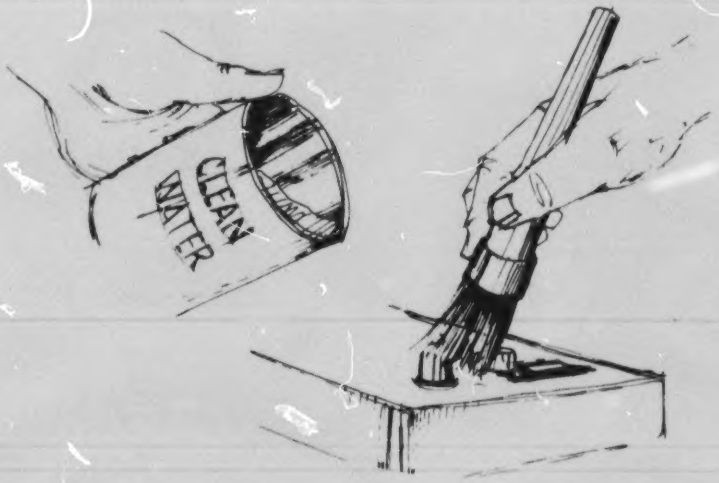
FIGURE 4



E. Wash away residue with clean water (Figure 5)

(NOTE: Remove all residue that may have lodged around battery, frame, or parts of the vehicle.)

FIGURE 5



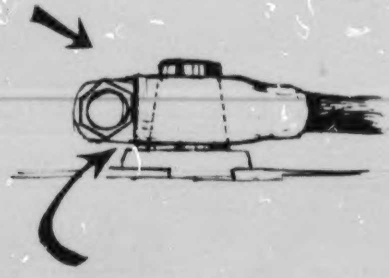
JOB SHEET #2

F. Dry the battery and battery cables with a clean cloth

G. Reconnect battery cables to the battery posts (Figure 6)

(CAUTION: Always reconnect the power cable first and the ground cable last.)

FIGURE 6



H. Spread a coating of battery anti-corrosion paste over the cable clamps and terminals

I. Remove vent caps and check electrolyte level in all cells

J. Add water if necessary to bring electrolyte up to proper level

(NOTE: Do not overfill.)

EQUIPMENT MAINTENANCE
UNIT I

JOB SHEET #3--MEASURE BATTERY ELECTROLYTE WITH A HYDROMETER

I. Tools and materials

   A. Hydrometer

   B. Shop towels

   C. Container of clean water

   D. Safety glasses

   E. Rubber gloves

   F. Rubber apron

II. Procedure

   A. Remove vent caps from battery

   B. Insert the hydrometer into the first cell

   C. Squeeze the rubber bulb to draw electrolyte into the hydrometer to suspend the float

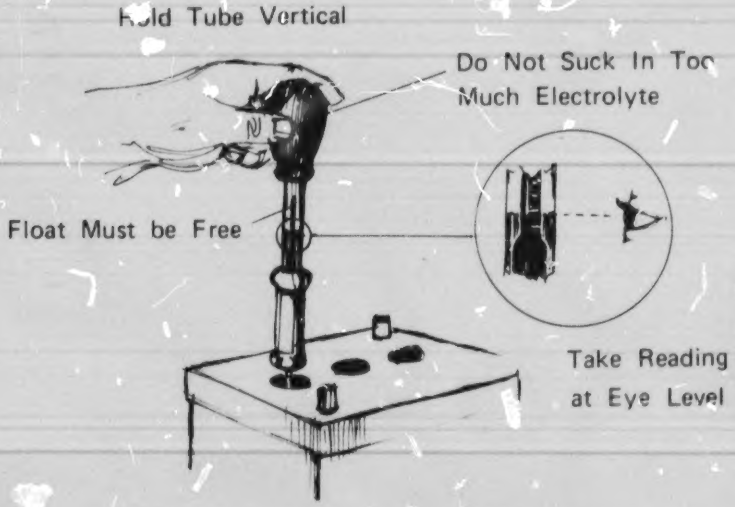
   (NOTE: If the electrolyte level is too low, add water, charge for one hour, and recheck.)

JOB SHEET #3

D. Take reading at eye level (Figure 1)

(NOTE: Make sure the float is not bumping the top of the hydrometer tube or sticking to the side of the tube. Write down reading for each cell.)

FIGURE 1


Hold Tube Vertical
Do Not Suck In Too Much Electrolyte
Float Must be Free
Take Reading at Eye Level

E. Squeeze bulb to return electrolyte to cell

F. Repeat for other cells

JOB SHEET #3

G. Adjust the readings for temperature

1. Add four gravity points (0.004) to the reading for every 10°F above 80°. Subtract four gravity points (0.004) for each 10° below 80°F (Figure 2)

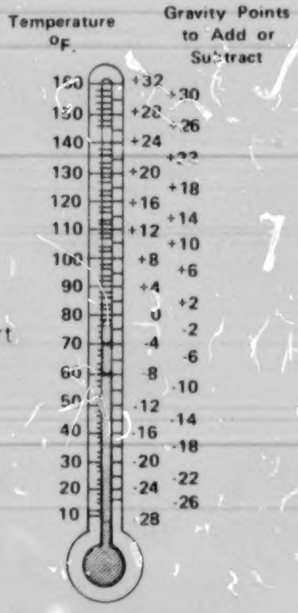


FIGURE 2

Temperature Adjustment Chart

2. Specific gravity should read from 1.215 to 1.270 (corrected for 80°F electrolyte temperature)

3. The variation in readings between cells should be no more than 0.050

4. If the readings are not within the above mentioned range, charge and retest

H. Replace vent caps upon completion of test

I. Flush any spilled electrolyte with clean water

EQUIPMENT MAINTENANCE
UNIT I

JOB SHEET #4--LOAD TEST A BATTERY

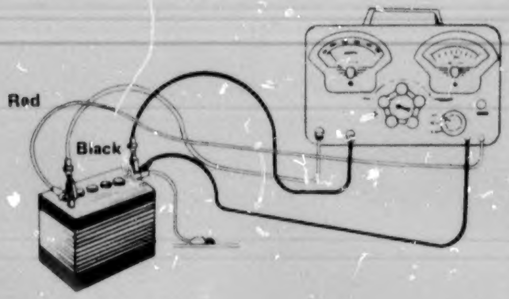
I. Tools and materials

- A. Battery capacity tester
- B. Appropriate conductors
- C. Safety glasses
- D. Rubber gloves
- E. Rubber apron

II. Procedure

- A. Connect tester (Figure 1)

FIGURE 1



Battery Capacity Test - 12V Battery

- B. Tighten rheostat knob to apply a load to battery
- C. Apply load equal to three times the ampere-hour rating of battery being tested

  (NOTE: Ampere-hour rating should be marked on the outside of battery case.)
- D. Read battery voltage at the end of 15 seconds

  (NOTE: If voltage drops below 1.5 volts per cell in 15 seconds use the 3-minute charge test.)
- E. Loosen rheostat to relieve load at end of 15 seconds
- F. Disconnect tester

EQUIPMENT MAINTENANCE
UNIT I

JOB SHEET #5--CHARGE TEST A BATTERY FOR THREE MINUTES

I. Tools and materials

A. Adjustable, fast rate battery charger

B. Battery capacity tester

C. Appropriate conductors

D. Safety glasses

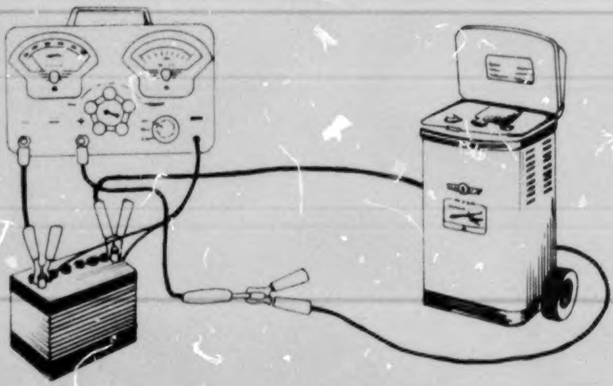
E. Rubber gloves

F. Rubber apron

II. Procedure

A. Connect tester and charger (Figure 1)

FIGURE 1



Battery Charge Test - 12V Battery

B. Turn charger on and adjust the charging rate to 40 amps

C. Charge battery for 3 minutes

D. Read individual cell voltages with battery charger still in operation

(NOTE: If they vary by more than 0.1 volt (1/10v), replace the battery.)

E. Read total battery voltage

(NOTE: If it is over 15.5v (15 1/2 volts), the battery is unsatisfactory and must be given a long slow charge and load tested again. If voltage under load test is less than 9v, replace battery.)

EQUIPMENT MAINTENANCE
UNIT I

JOB SHEET #6--ADJUST V-BELT TENSION

I. Tools and materials

A. Safety glasses

B. Hand tool assortment

C. Straight edge

D. Belt driven equipment

E. Appropriate equipment service manual

II. Procedure

A. Put on safety glasses and disconnect the spark plug lead and ground it to the block

B. Remove V-belt

C. Check pulley alignment (Figure 1)

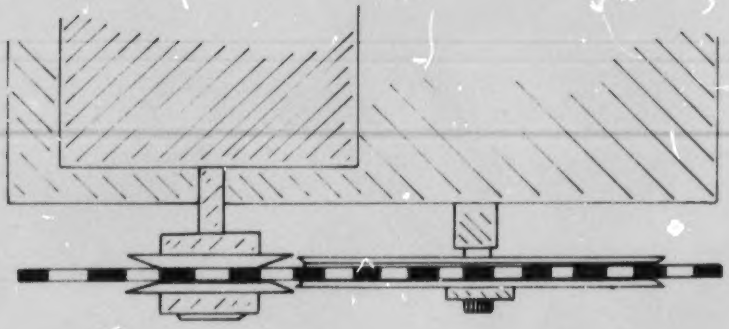


FIGURE 1

D. Place a straight edge in the pulley grooves to check alignment

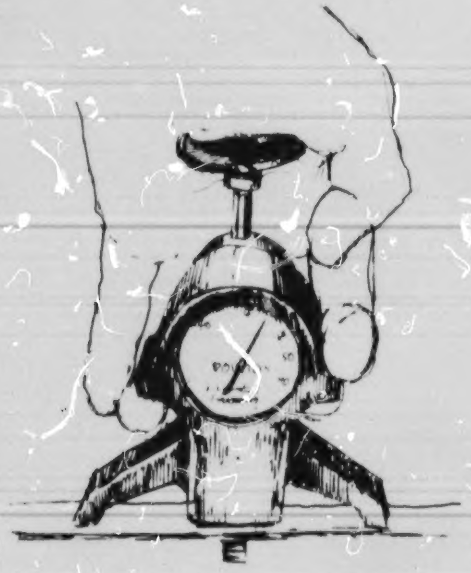
(NOTE: If pulleys do not align, loosen set screws and align them.)

E. Replace belt

JOB SHEET #6

F. Check belt tension with a belt tension gauge and adjust to manufacturer's specifications (Figure 2)

FIGURE 2



CHECK BELT FOR TIGHTNESS

G. Have instructor evaluate your work

EQUIPMENT MAINTENANCE
UNIT I

NAME ______________________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. All equipment designed to maintain a lawn or garden

_____b. Equipment designed as an optional component part

_____c. Routine service procedures necessary to keep equipment operating safely and efficiently

_____d. Relating to air or air pressure

_____e. Equipment designed to detect an uneven distribution of weight from the center mounting hole to the blade tips

_____f. Two or more connected cells which convert chemical energy into electrical energy

_____g. One negative and one positive plate group

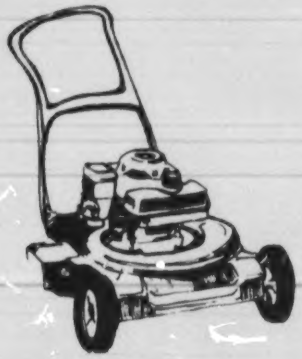
_____h. Solution of water and sulphuric acid

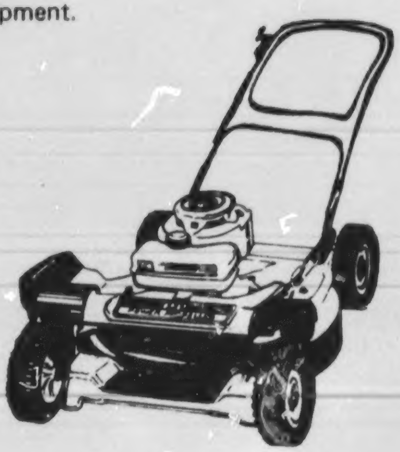
_____i. Weight of liquid compared to an equal volume of water at 60°F

_____j. Glass barrel syringe containing a calibrated float used to measure specific gravity

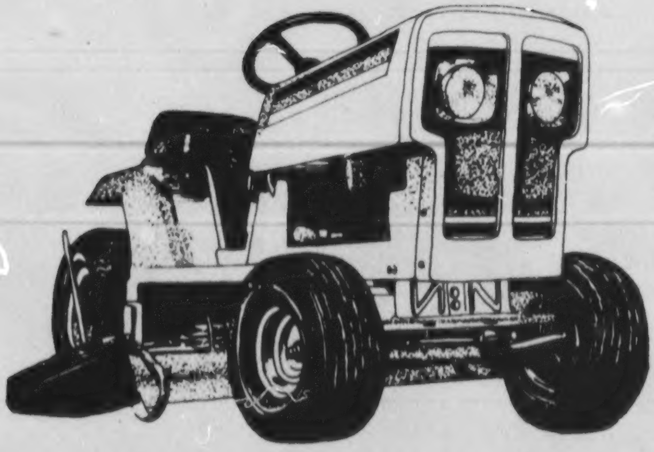
1. Pneumatic
2. Blade balancer
3. Accessory
4. Maintenance
5. Lawn and garden equipment
6. Specific gravity
7. Battery
8. Hydrometer
9. Cell
10. Electrolyte

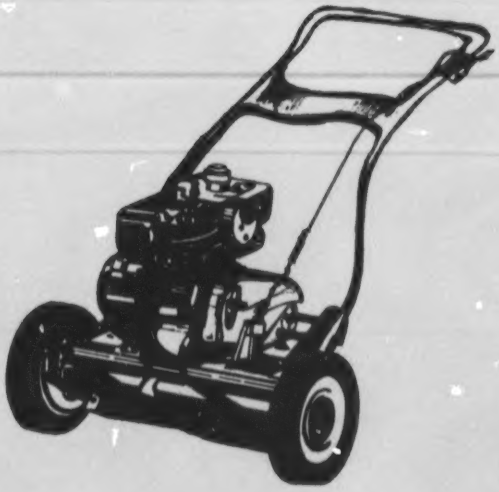
2. Identify the common types of lawn and garden equipment.



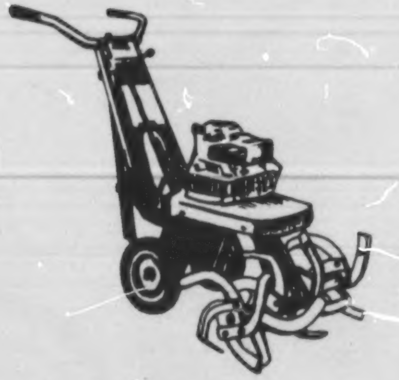


a. ______________________________ b. ______________________________

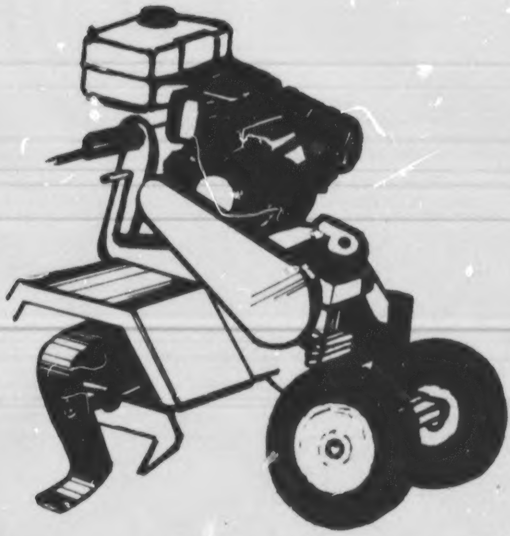




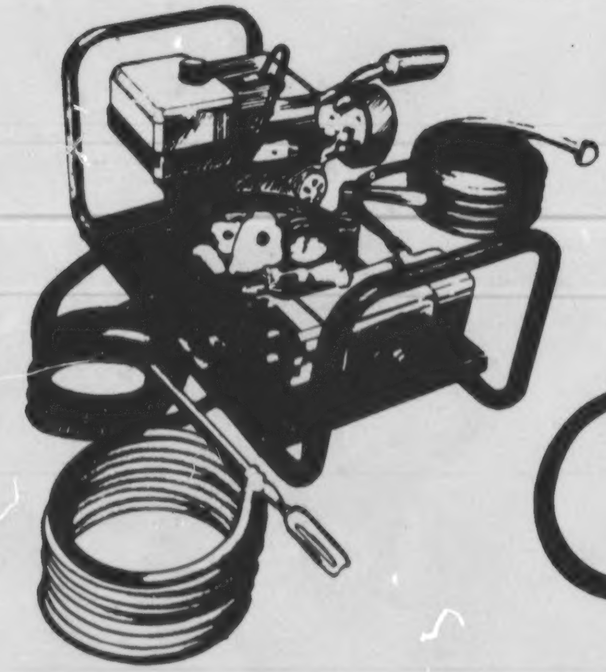
c. ______________________________ d. ______________________________



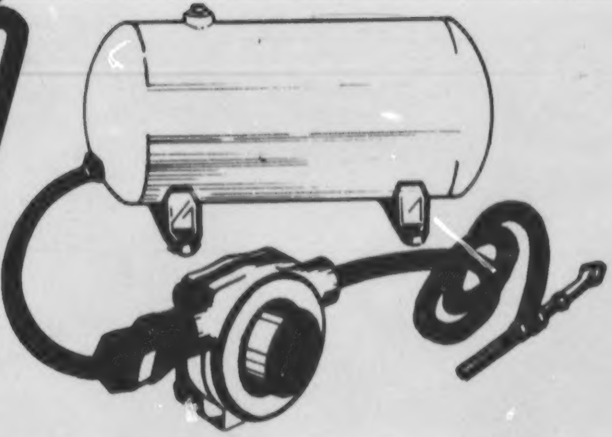
e. ______________________



f. ______________________

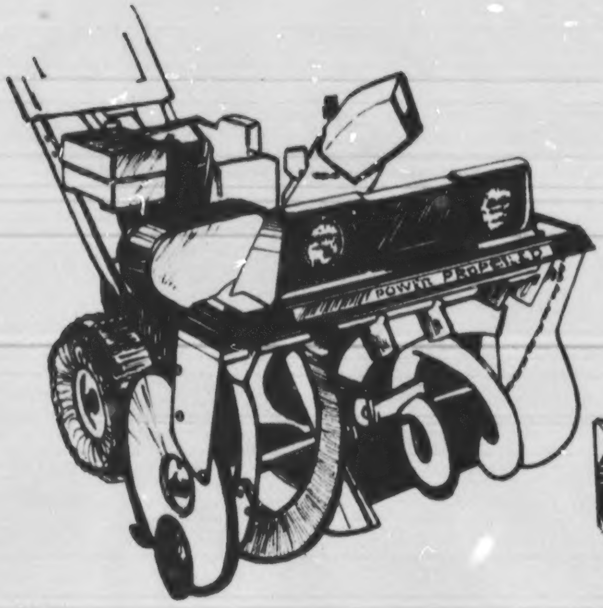


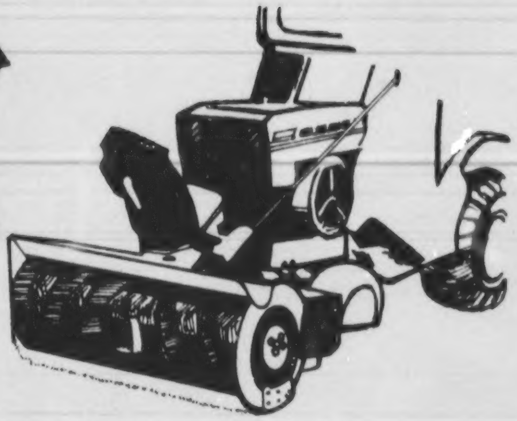
g. ______________________



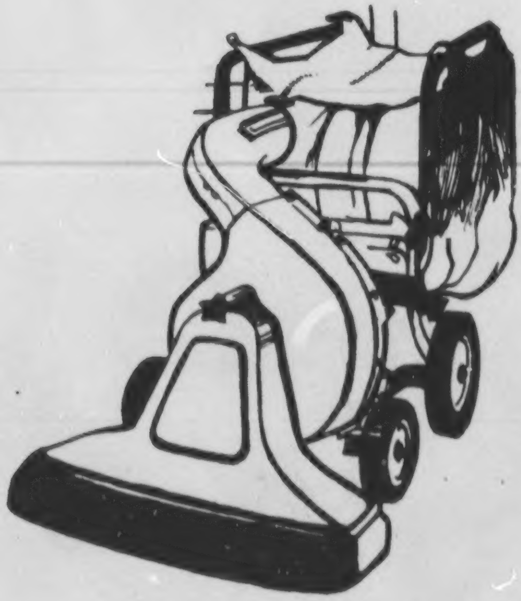
h. ______________________

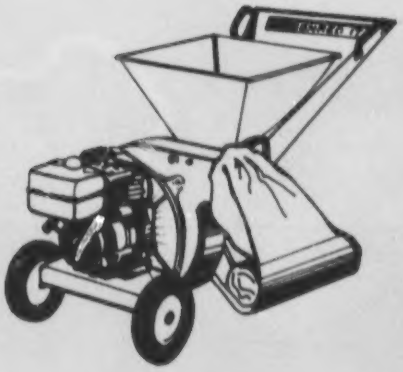
34-B



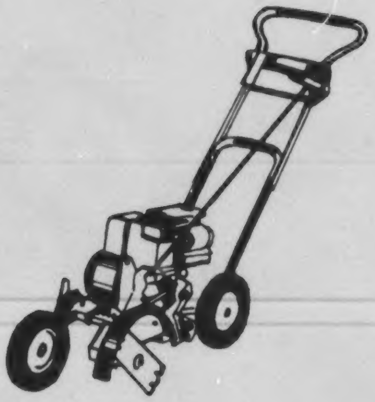


i. ______________________ j. ______________________





k. ______________________ l. ______________________



m. ______________________________

3. List five basic equipment maintenance procedures for lawn and garden equipment.
   a.
   b.
   c.
   d.
   e.

4. List three common battery functions.
   a.
   b.
   c.

5. Demonstrate the ability to:
   a. Sharpen a rotary mower blade.
   b. Clean and service a battery.
   c. Measure battery electrolyte with an hydrometer.
   d. Load test a battery.
   e. Charge test a battery for three minutes.
   f. Adjust a V-belt.

EQUIPMENT MAINTENANCE
UNIT I

ANSWERS TO TEST

1. a. 5
   b. 3
   c. 4
   d. 1
   e. 2
   f. 7
   g. 9
   h. 10
   i. 6
   j. 8

2. a. Rotary mower
   b. Rotary self propelled mower
   c. Lawn and garden tractor accessory
   d. Reel
   e. Walk behind tiller
   f. Tractor accessory tiller
   g. Unit sprayer
   h. Tractor accessory sprayer
   i. Unit snow blower
   j. Tractor accessory snow blower
   k. Lawn vacuums
   l. Shredders
   m. Edger-trimmer

3. Any five of the following:
   a. Keep all belts properly adjusted and clean
   b. Maintain proper tension on chains
   c. Lubricate moving parts according to manufacturer's specifications

   d. Service engines according to manufacturer's specifications
   e. Keep all blades balanced and cutting edges sharp
   f. Maintain proper inflation on all pneumatic tires
   g. Service batteries according to manufacturer's specifications

4. a. Supply current for cranking engine
   b. Provide current for meeting demands above charging output
   c. Stabilize system voltage

5. Performance skills evaluated to the satisfaction of the instructor

BRAKES
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to select the types of brakes most often found on lawn and garden equipment and name the parts of the different types of brakes. The student should also be able to match the operations to the correct type of brake and demonstrate the ability to disassemble, inspect, and reassemble all types of brake units. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Select the types of brakes most often used on lawn and garden equipment.
2. Name the six major components of the external band brake.
3. Name the nine major components of the disc brake
4. Name the seven major components of the drum and shoe brake.
5. Match the types of brakes to the correct operations.
6. Demonstrate the ability to:
    a. Disassemble, inspect, and reassemble an external band brake.
    b. Disassemble, inspect, and reassemble a disc brake.
    c. Disassemble, inspect, and reassemble a drum and shoe brake.

BRAKES
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide student with objective sheet.
- B. Provide student with information and job sheets.
- C. Make transparencies.
- D. Discuss unit and specific objectives.
- E. Discuss information sheet.
- F. Demonstrate and discuss the procedures outlined in the job sheets.
- G. Show students types of brakes used on lawn and garden equipment.
- H. Give test.

II. Student:

- A. Read objective sheet.
- B. Study information sheet.
- C. Complete job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheet
- C. Transparency masters
  - 1. TM 1--External Band Brakes
  - 2. TM 2--Disc Brakes
  - 3. TM 3--Drum and Shoe Brakes

D. Job sheets

1. Job Sheet #1--Disassemble, Inspect, and Reassemble an External Band Brake

2. Job Sheet #2--Disassemble, Inspect, and Reassemble a Disc Brake

3. Job Sheet #3--Disassemble, Inspect, and Reassemble a Drum and Shoe Brake

E. Test

F. Answers to test

II. Reference--*Small Tractor Service Manual.* Vol. 1 Kansas City, Missouri: Technical Publications Division/Intertec Publishing Corp., 1975.

BRAKES
UNIT I

INFORMATION SHEET

I. Types of brakes
  - A. External band
  - B. Disc
  - C. Drum and shoe

II. Major components of external band brake (Transparency 1)
  - A. Brake pedal
  - B. Brake rod
  - C. Brake band
  - D. Brake drum
  - E. Return spring
  - F. Relay shaft

III. Major components of disc brake (Transparency 2)
  - A. Brake disc
  - B. Brake pedal
  - C. Brake rod
  - D. Relay shaft
  - E. Brake cam
  - F. Lining carrier
  - G. Lining
  - H. Return spring
  - I. Cam actuator

IV. Major components of drum and shoe brake (Transparency 3)
  - A. Brake drum
  - B. Brake shoe

INFORMATION SHEET

C. Brake backing plate

D. Return spring

E. Brake pedal

F. Adjustor

G. Brake rod

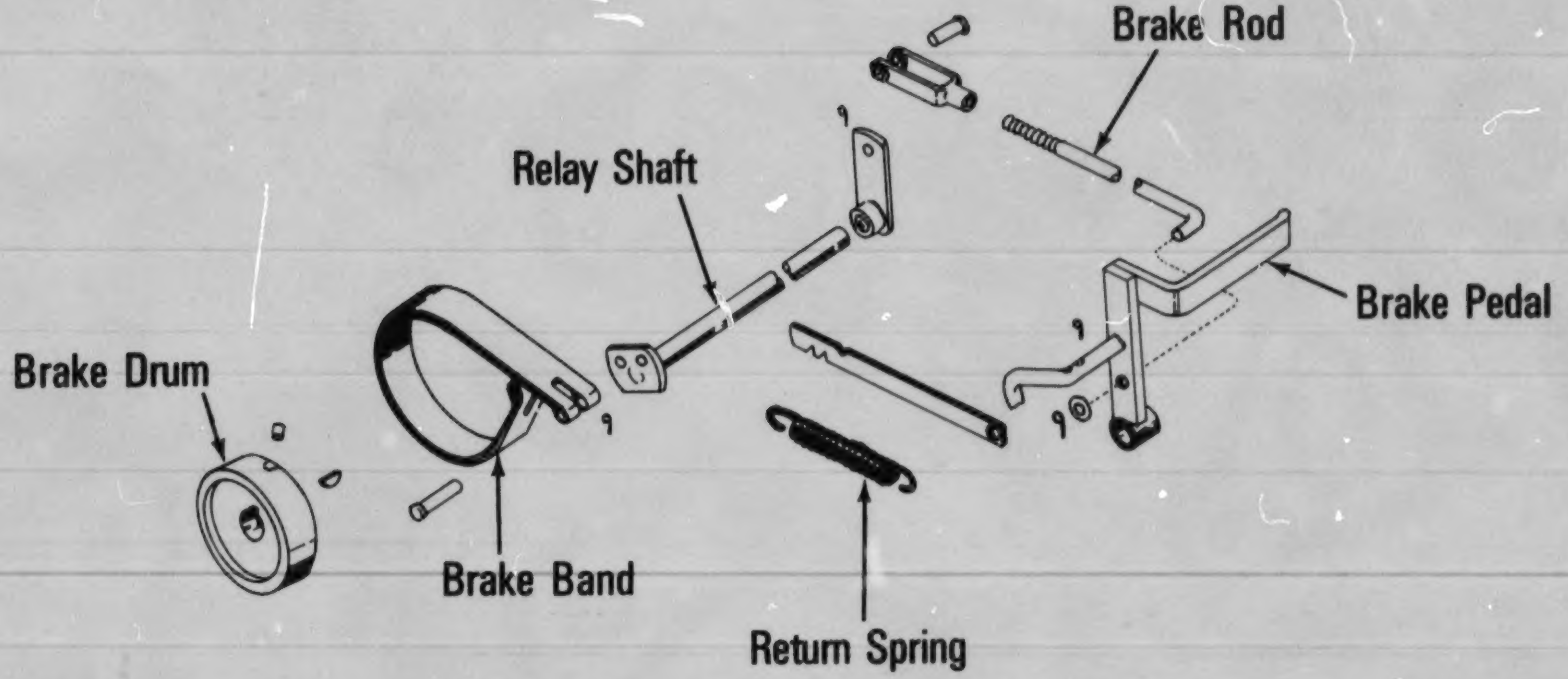
V. Operations of the types of brakes

A. External band--Brake band contracts to grip outside surface of brake drum

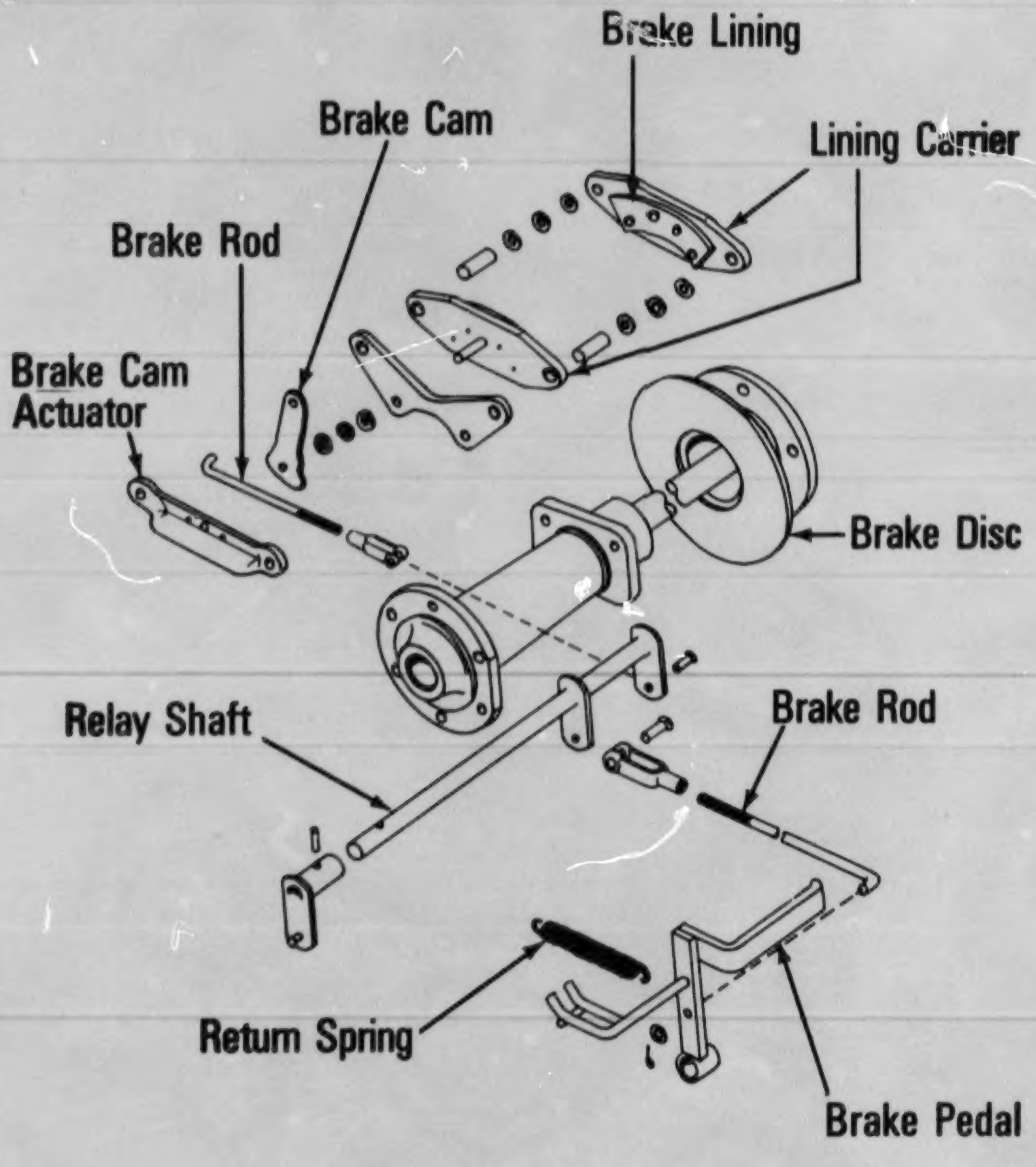
B. Disc--Rotating cam reacts against actuator to clamp brake disc between lining carriers

C. Drum and shoe--Brake shoe moves outward and contacts inside surface of brake drum

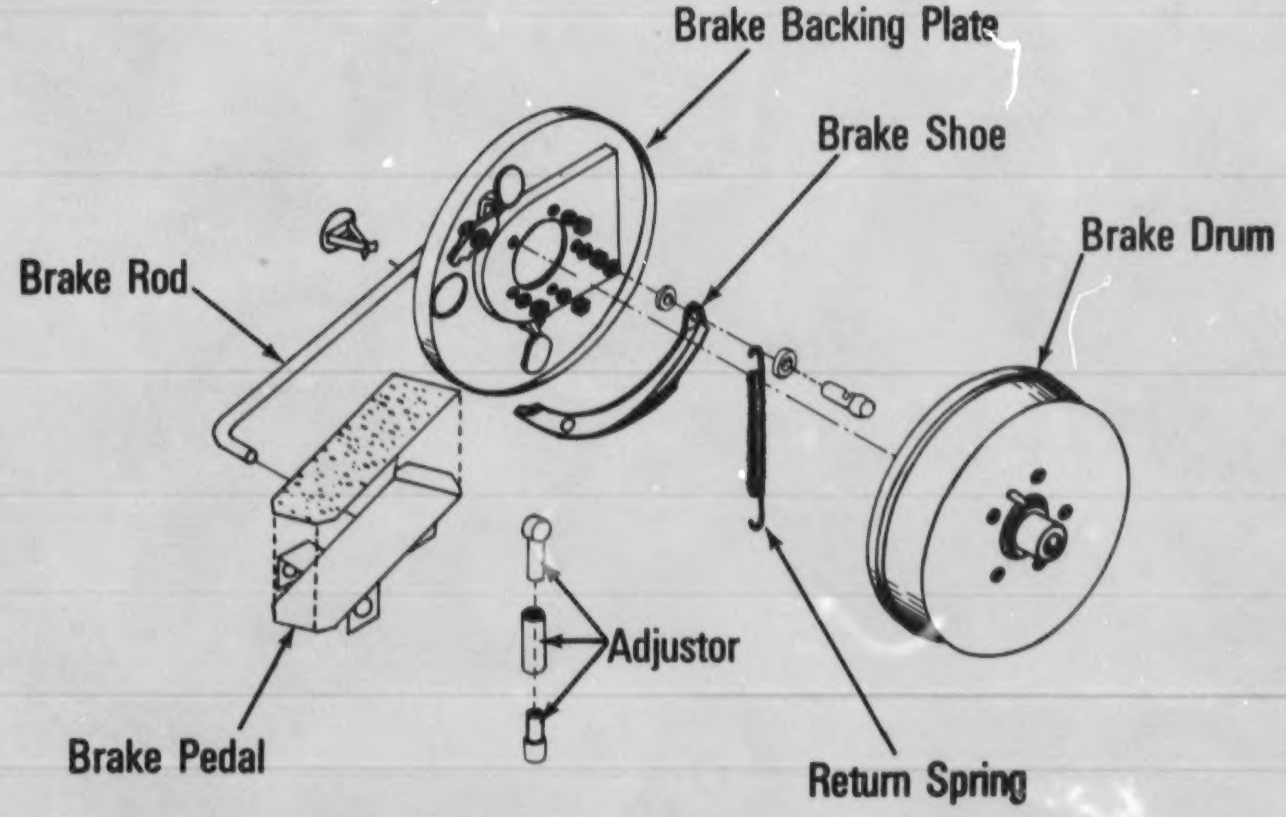
External Band Brakes


Brake Rod
Relay Shaft
Brake Pedal
Brake Drum
Brake Band
Return Spring

Disc Brakes


Brake Lining
Brake Cam
Lining Carrier
Brake Rod
Brake Cam Actuator
Brake Disc
Relay Shaft
Brake Rod
Return Spring
Brake Pedal

Drum and Shoe Brakes


Brake Backing Plate
Brake Shoe
Brake Drum
Brake Rod
Adjustor
Brake Pedal
Return Spring

BRAKES
UNIT I

JOB SHEET #1--DISASSEMBLE, INSPECT, AND REASSEMBLE AN EXTERNAL BAND BRAKE

I. Tools and materials

   A. Hand tool assortment

   B. Appropriate service manual

II. Procedure

   A. Disconnect spark plug wire and connect to ground

   B. Disconnect brake rod

   C. Disconnect brake band from linkage

   D. Remove brake band from drum

   E. Inspect band lining for thickness and cracks

   (NOTE: If lining is riveted to band, be certain lining thickness is sufficient so that rivet heads do not contact drum.)

   F. Inspect connecting points of band for cracks or excessive wear

   G. Inspect brake drum for excessive or uneven wear

   H. Inspect brake drum for heat damage

   (NOTE: Heat damage will be evidenced by discoloration and tiny cracks in the braking surface.)

   I. Reinstall brake band on drum

   J. Connect brake linkage

   K. Adjust brake linkage according to specifications in appropriate service manual

BRAKES
UNIT I

JOB SHEET #2--DISASSEMBLE, INSPECT, AND REASSEMBLE A DISC BRAKE

I. Tools and materials

- A. Hand tool assortment
- B. Appropriate service manual
- C. Hydraulic jack
- D. Multipurpose grease
- E. Vehicle stand or blocks

II. Procedure

- A. Disconnect spark plug wire and connect to ground
- B. Raise and block rear of vehicle so that rear wheels do not touch the ground
- C. Remove rear wheels
- D. Disconnect brake linkage
- E. Unbolt and remove brake assemblies from axle housing

  (NOTE: Consult appropriate service manual for exact procedures.)
- F. Disassemble brake units
- G. Inspect lining for thickness and uneven wear
- H. Inspect lining for heat damage

  (NOTE: Heat damage will be evidenced by discoloration and tiny cracks in the lining surface.)
- I. Inspect lining carriers for warpage
- J. Inspect cam and cam actuator for excessive wear
- K. Inspect brake disc for smoothness and uneven wear
- L. Inspect brake disc for heat damage
- M. Replace brake lining, if necessary

  (NOTE: Consult appropriate service manual for correct procedure.)

JOB SHEET #2

N. Lubricate cam and cam actuator lightly with multipurpose grease

O. Assemble brake units

P. Reinstall brake units on rear axle

Q. Connect brake linkage

R. Adjust brake linkage

(NOTE: Consult appropriate service manual for exact adjustment specifications.)

S. Reinstall rear wheels

T. Remove blocks and lower vehicle

BRAKES
UNIT I

JOB SHEET #3--DISASSEMBLE, INSPECT, AND REASSEMBLE A DRUM AND SHOE BRAKE

I. Tools and materials

A. Hand tool assortment

B. Appropriate service manual

C. Hydraulic jack

D. Multipurpose grease

E. Vehicle stand or blocks

F. Wheel puller

G. Torque wrench

II. Procedure

A. Disconnect spark plug wire and connect to ground

B. Raise and block rear of vehicle so that rear wheels do not touch the ground

C. Remove rear wheels

D. Remove axle nut and washer that secure brake drum to axle

E. Remove brake drum from axle using the wheel puller

(NOTE: It may be necessary to loosen the adjustment of the brake shoe to remove the drum.)

F. Remove brake shoe return spring

G. Remove brake shoe anchor bolt and brake shoe from backing plate

H. Inspect brake lining for thickness and uneven wear

I. Inspect brake lining for heat damage

(NOTE: Heat damage will be evidenced by discoloration and cracks in the lining.)

J. Replace or reline brake shoe, if necessary

JOB SHEET #3

K. Inspect brake drum for smoothness or excessive wear

L. Inspect drum for heat damage

M. Resurface brake drum, if necessary

N. Inspect brake adjusting mechanism for free movement and lubricate

O. Install brake shoe and brake shoe anchor bolt

P. Install brake shoe return spring

Q. Install brake drum

R. Install axle nut and washer

(NOTE: Consult appropriate service manual for correct torque specifications.)

S. Adjust brakes

(NOTE: Consult appropriate service manual for exact procedures.)

T. Install rear wheels

U. Remove blocks and lower vehicle

BRAKES
UNIT I

NAME ____________________

TEST

1. Select the types of brakes most often used on lawn and garden equipment by placing an "X" in the appropriate blanks.

_____a. Hydraulic

_____b. Drum and shoe

_____c. Caliper

_____d. External band

_____e. Hydrostatic

_____f. Disc

2. Name the six major components of the external band brake.

a.

b.

c.

d.

e.

f.

3. Name the nine major components of the disc brake.

a.

b.

c.

d.

e.

f.

g.

h.

i.

4. Name the seven major components of the drum and shoe brake.

a.

b.

c.

d.

e.

f.

g.

5. Match the types of brakes on the right to the correct operations.

_____a.	Rotating cam reacts against actuator to clamp brake disc between lining carriers	1.	External band
		2.	Disc
_____b.	Brake shoe moves outward and contacts inside surface of brake drum	3.	Drum and shoe
_____c.	Brake band contracts to grip outside surface of brake drum		

6. Demonstrate the ability to:

a. Disassemble, inspect, and reassemble an external band brake.

b. Disassemble, inspect, and reassemble a disc brake.

c. Disassemble, inspect, and reassemble a drum and shoe brake.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

BRAKES
UNIT I

ANSWERS TO TEST

1. b, d, f

2. a. Brake pedal
   b. Brake rod
   c. Brake band
   d. Brake drum
   e. Return spring
   f. Relay shaft

3. a. Brake disc
   b. Brake pedal
   c. Brake rod
   d. Relay shaft
   e. Brake cam
   f. Lining carrier
   g. Lining
   h. Return spring
   i. Cam actuator

4. a. Brake drum
   b. Brake shoe
   c. Brake backing plate
   d. Return spring
   e. Brake pedal
   f. Adjustor
   g. Brake rod

5. a. 2

   b. 3

   c. 1

6. Performance skills evaluated to the satisfaction of the instructor

CLUTCHES
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to list the types of clutches and describe the operation of the various clutches found on lawn and garden equipment. The student should also be able to inspect and adjust a belt tension idler clutch and inspect a plate clutch. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. List two types of clutches used on lawn and garden equipment.
2. Describe the operation of a belt tension idler clutch.
3. Describe the operation of a plate clutch.
4. Match types of belt damage to probable causes.
5. Demonstrate the ability to:
    a. Inspect and adjust a belt tension idler clutch.
    b. Disassemble, inspect, and reassemble a plate clutch.

CLUTCHES
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.
  B. Provide student with information and job sheets.
  C. Make transparencies.
  D. Discuss unit and specific objectives.
  E. Discuss information sheet.
  F. Demonstrate and discuss the procedures outlined in the job sheets.
  G. Obtain samples of damaged pulleys and damaged belts for illustration.
  H. Give test.

II. Student:

  A. Read objective sheet.
  B. Study information sheet.
  C. Complete job sheets.
  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet
  B. Information sheet
  C. Transparency masters
    1. TM 1--Belt Tension Idler Clutch
    2. TM 2--Plate Clutch
    3. TM 3--Operation of Belt Tension Idler Clutch

4. TM 4--Operation of Plate Clutch
5. TM 5--Belt Damage

D. Job sheets

1. Job Sheet #1--Inspect and Adjust a Belt Tension Idler Clutch
2. Job Sheet #2--Disassemble, Inspect, and Reassemble a Plate Clutch

E. Test

F. Answers to test

II. References:

A. *John Deere Service Manual: Walk-Behind Equipment.* Moline, Illinois: Deere and Co., 1974.

B. *Grounds Keeping Equipment.* Vol. 1. Athens, Georgia: American Association for Vocational Instructional Materials, 1974.

C. *Small Tractor Service Manual.* Vol 1. Kansas City, Missouri: Technical Publications Division/Intertec Publishing Corp., 1975.

D. *Small Tractor Service Manual.* Vol 2. 4th ed. Kansas City, Missouri: Technical Publications Division/Intertec Publishing Corp., 1975.

CLUTCHES
UNIT I

INFORMATION SHEET

I. Types of clutches used on lawn and garden equipment

  A. Belt tension idler (Transparency 1)

  B. Plate (Transparency 2)

II. Operation of belt tension idler clutch (Transparency 3)

  A. Operator depresses clutch pedal

  B. Motion transmitted through mechanical linkage connecting pedal to idler pulley

  C. Pedal action overcomes engaging spring tension

  D. No power transmitted when belt is not under tension

  E. Operator releases pedal

  F. Engaging spring presses idler pulley against belt

  G. Power is transmitted when belt is under tension

III. Operation of plate clutch (Transparency 4)

  A. Operator depresses clutch pedal

  B. Pedal action overcomes spring tension

  C. Pressure plates and clutch disc separate to interrupt power flow

  D. Operator releases clutch pedal

  E. Spring tension compresses pressure plates and clutch disc

  F. Friction between plates and disc causes power to flow

IV. Types of belt damage and probable causes (Transparency 5)

  A. Rapid belt wear--Excessive pulley sidewall wear

  B. Cut or broken belts--Bent or chipped pulley sidewall

INFORMATION SHEET

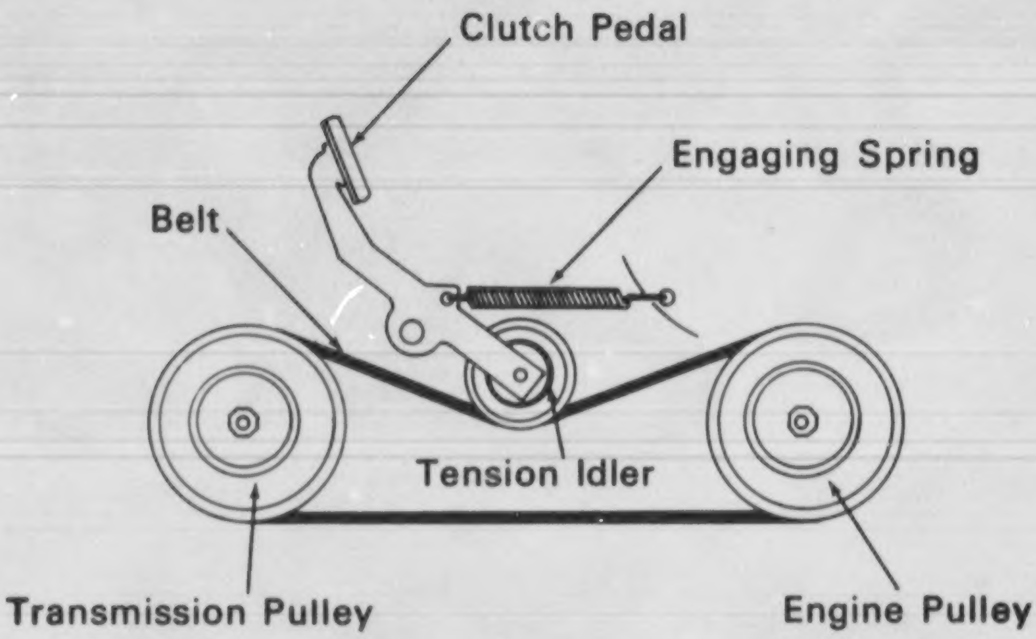
C. Slipping and burning belt--Undertension

(NOTE: Replace weak or stretched idler springs and keep adjustment to manufacturer's specifications.)

D. Stretched or broken cords--Overtension

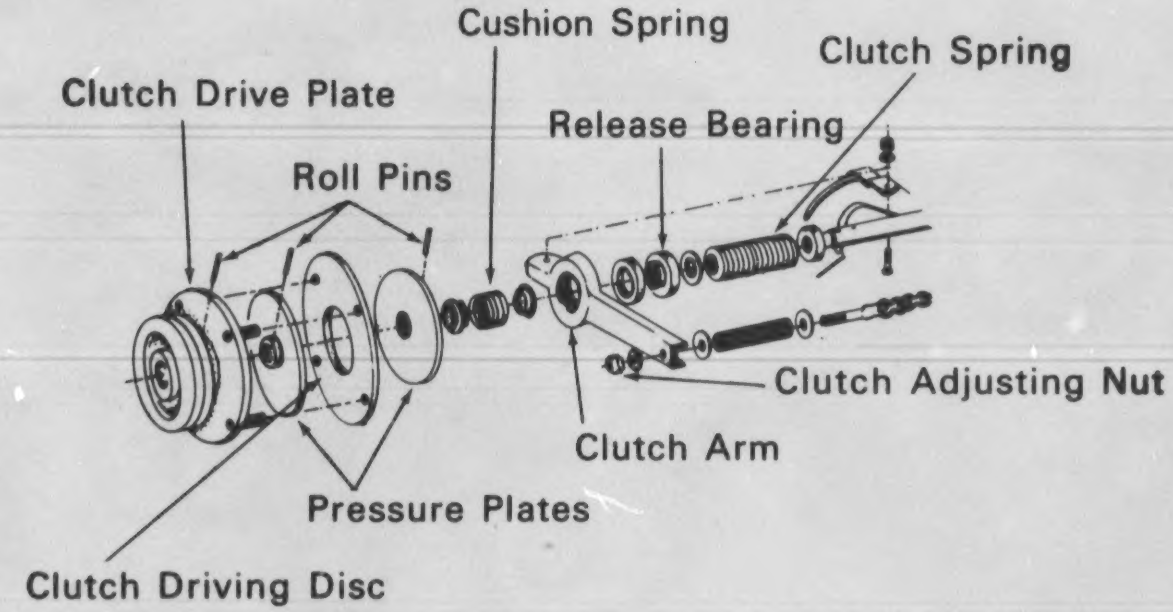
E. Excessive sidewall wear--Incorrect belt size or type installed

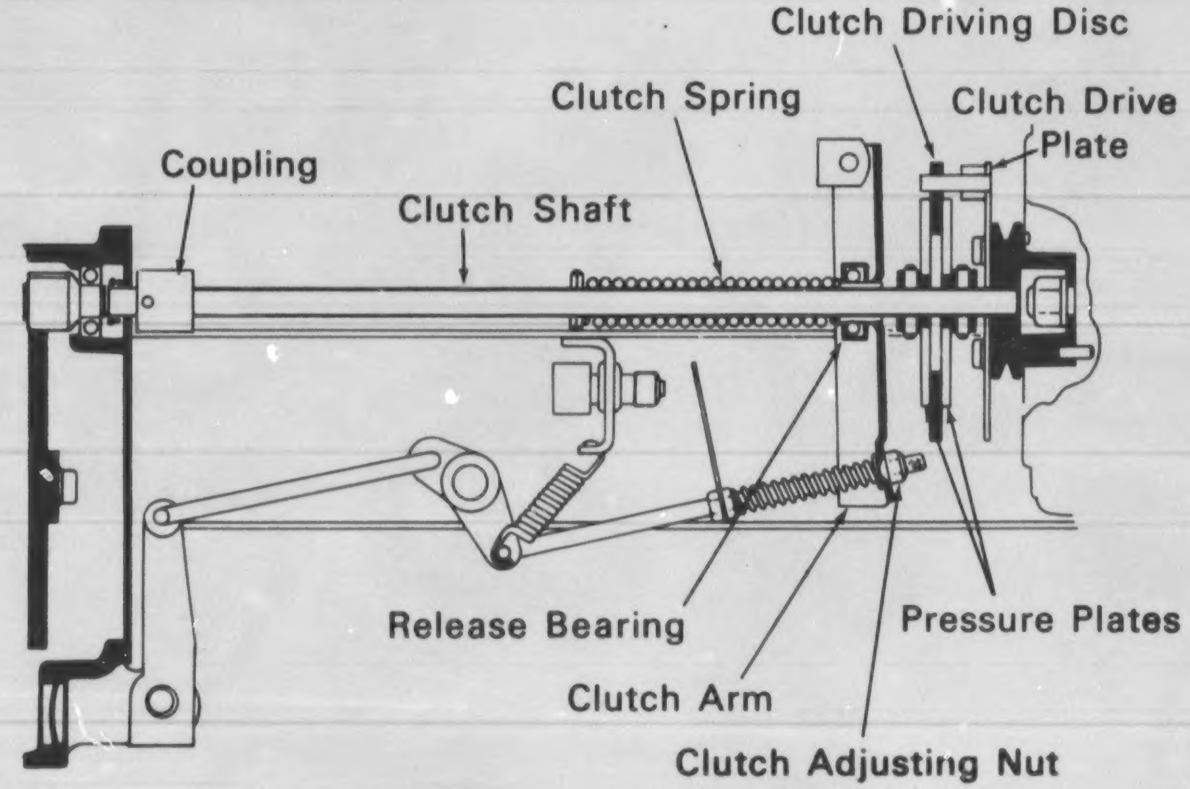
Belt Tension Idler Clutch


Clutch Pedal
Engaging Spring
Belt
Tension Idler
Transmission Pulley
Engine Pulley

Tension Idler Clutch for Belt Drive Tractor

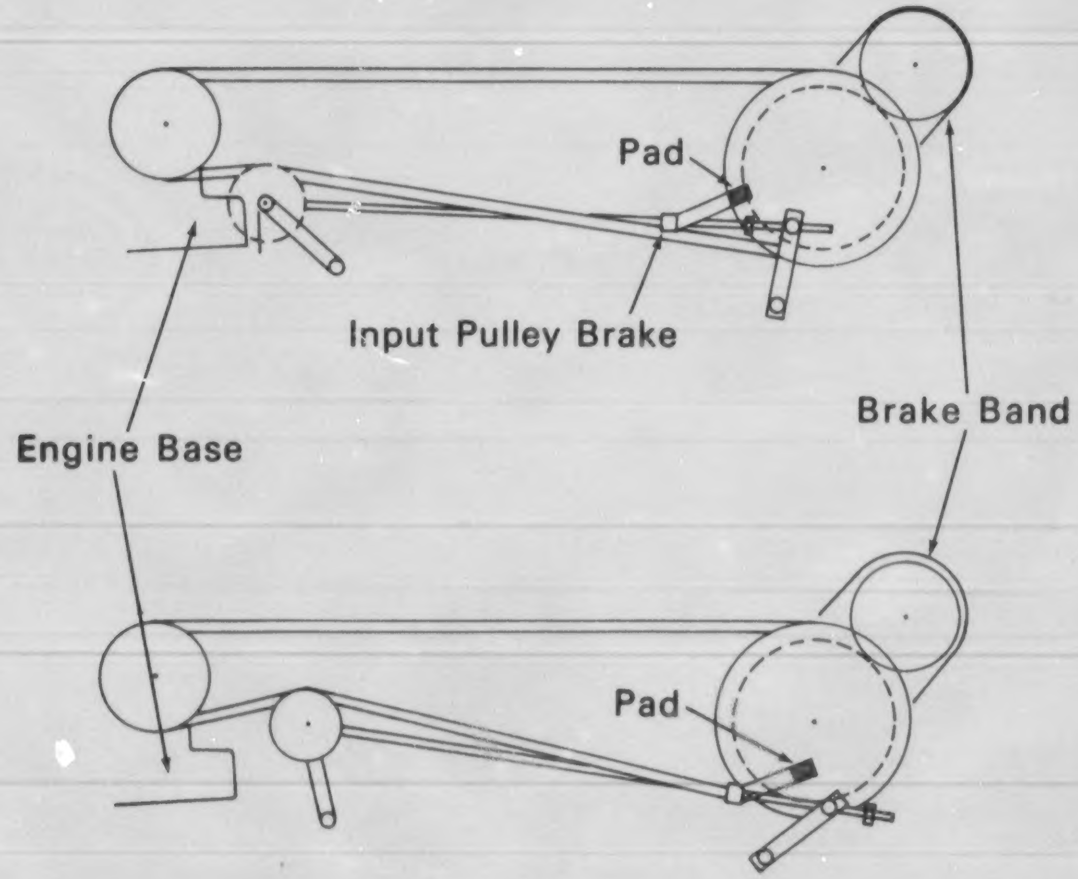
Plate Clutch


Cushion Spring
Clutch Spring
Clutch Drive Plate
Release Bearing
Roll Pins
Clutch Adjusting Nut
Clutch Arm
Pressure Plates
Clutch Driving Disc


Clutch Driving Disc
Clutch Spring
Clutch Drive Plate
Coupling
Clutch Shaft
Release Bearing
Pressure Plates
Clutch Arm
Clutch Adjusting Nut

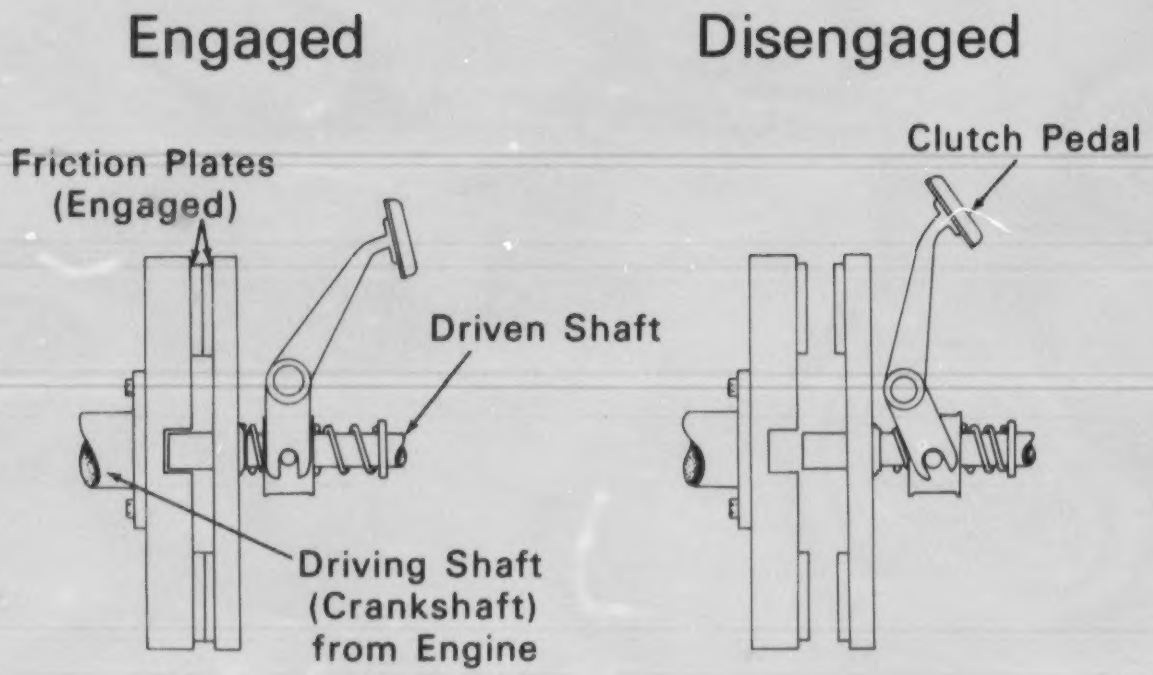
Operation of Belt Tension Idler Clutch

Clutch Disengaged


Pad
Input Pulley Brake
Engine Base
Brake Band
Pad

Clutch Engaged

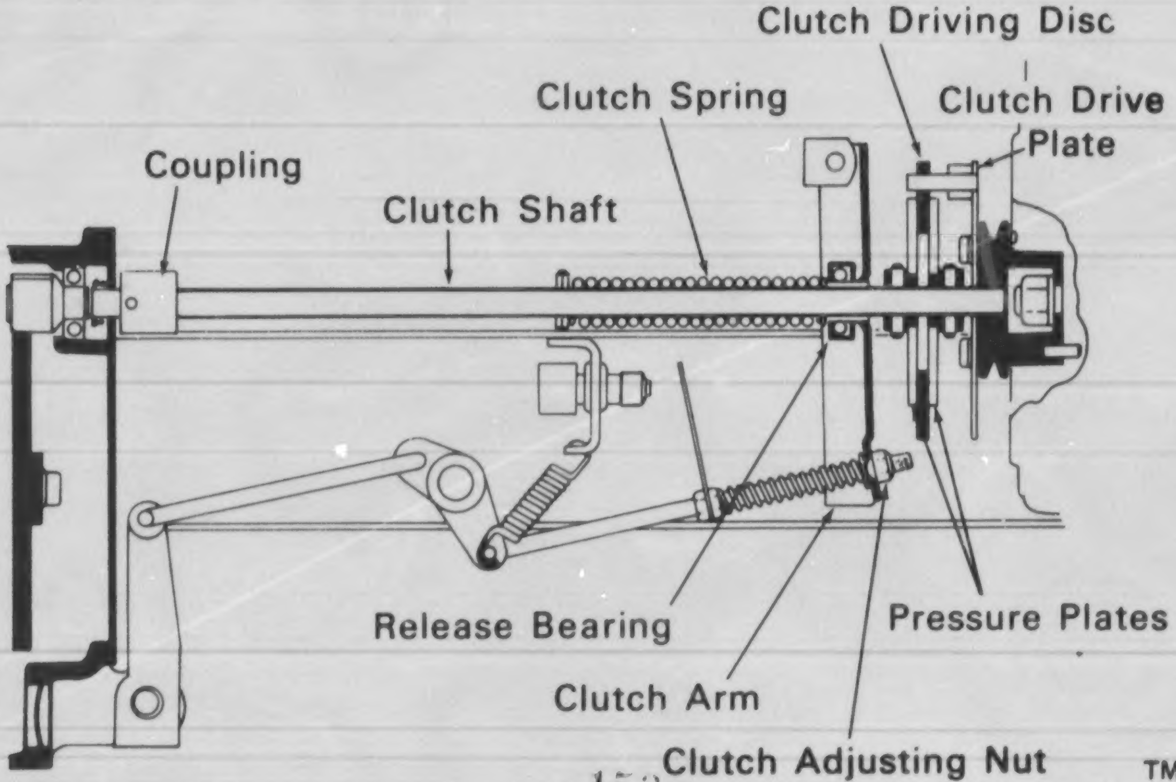
Operation of Plate Clutch



Engaged

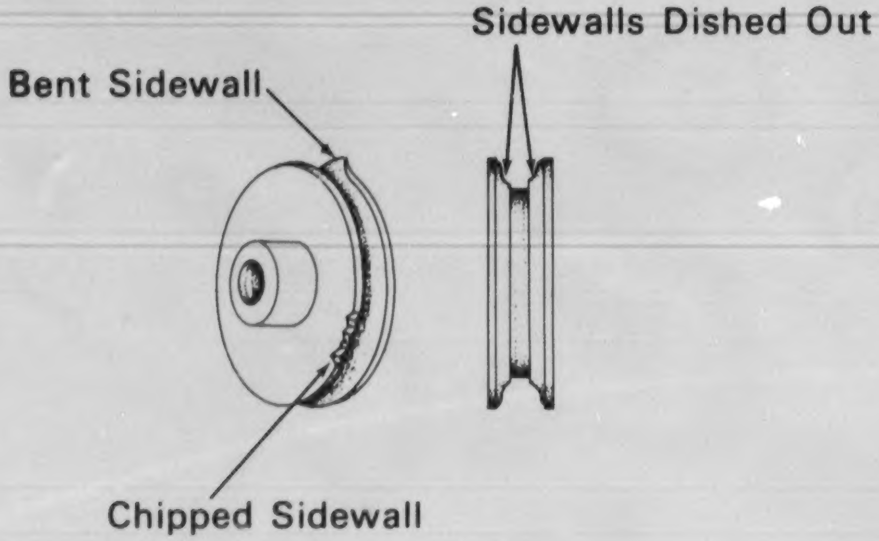
Disengaged

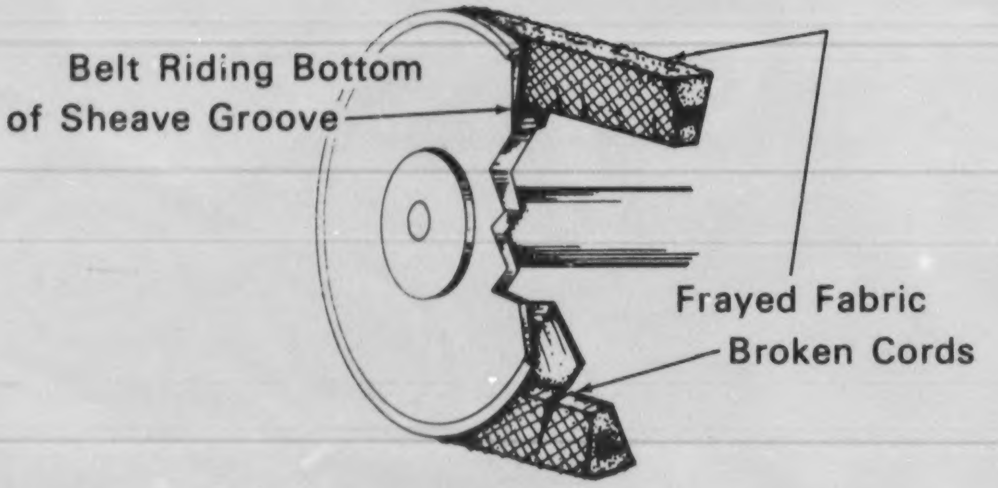
Friction Plates
(Engaged)
Driven Shaft
Driving Shaft
(Crankshaft)
from Engine
Clutch Pedal



Clutch Driving Disc
Clutch Spring
Clutch Drive Plate
Coupling
Clutch Shaft
Release Bearing
Pressure Plates
Clutch Arm
Clutch Adjusting Nut

Belt Damage


Sidewalls Dished Out
Bent Sidewall
Chipped Sidewall


Belt Riding Bottom of Sheave Groove
Frayed Fabric
Broken Cords

CLUTCHES
UNIT I

JOB SHEET #1--INSPECT AND ADJUST A BELT TENSION IDLER CLUTCH

I. Tools and materials

- A. Hand tool assortment
- B. Appropriate service manual

II. Procedure

(NOTE: Consult appropriate service manual for exact procedure for make and model being repaired.)

- A. Unhook spark plug wire and ground
- B. Locate clutch idler and clutch linkage adjustment
- C. Rotate drive pulley slowly and inspect pulley for damage and excessive wear
- D. Rotate drive pulley slowly and inspect idler pulley for damage and excessive wear

  (NOTE: Also check the condition of the center bearing or bushing.)
- E. Rotate drive pulley slowly and inspect driven pulley for damage and excessive wear
- F. Rotate drive pulley slowly and inspect drive belt for damage and excessive wear
- G. Inspect clutch linkage for damage and excessive wear
- H. Adjust clutch linkage according to manufacturer's specifications

  (CAUTION: Do not attempt to adjust clutch linkage while the engine is running.)

CLUTCHES
UNIT I

JOB SHEET #2--DISASSEMBLE, INSPECT, AND REASSEMBLE A PLATE CLUTCH

I. Tools and materials

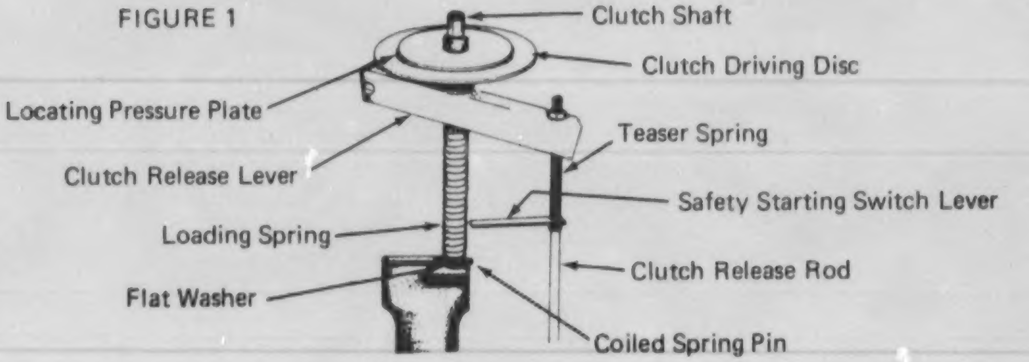
- A. Hand tool assortment
- B. Appropriate service manual
- C. Large "C" clamps (2) or hydraulic press
- D. Chassis grease
- E. Appropriate torque wrench

II. Procedure

(NOTE: Consult appropriate service manual for exact procedure for make and model being repaired.)

- A. Disconnect spark plug wire and connect to ground
- B. Remove bolts holding engine to frame
- C. Move engine forward enough to clear clutch
- D. Disconnect clutch release linkage
- E. Disconnect clutch shaft coupling at rear
- F. Remove clutch shaft and clutch assembly
- G. Remove clutch shaft coupling
- H. Clamp clutch assembly in a vise (Figure 1)

FIGURE 1


Clutch Shaft
Clutch Driving Disc
Locating Pressure Plate
Teaser Spring
Clutch Release Lever
Safety Starting Switch Lever
Loading Spring
Clutch Release Rod
Flat Washer
Coiled Spring Pin

JOB SHEET #2

I. Remove coiled spring pin

J. Slowly release vise and allow the spring to extend as the shaft slips through the vise

K. Support the hubs of the pressure plates, and then drive their pins out

L. Disassemble clutch

M. Inspect clutch driving disc for:

  1. Wear from pressure plates

  2. Elongated holes from driving pins

  (NOTE: Disc must be free from grease and oil.)

N. Inspect both pressure plates for warping and wear on contact surfaces

O. Inspect slotted hub of rear pressure plate for pin wear

  (NOTE: If slots are cupped from pin wear, plate must be replaced.)

P. Check loading spring tension

  (NOTE: Refer to appropriate service manual for specifications.)

Q. Inspect clutch release lever for wear where it contacts the release bearing

R. Inspect clutch shaft for wear at the pilot shaft area

S. Install clutch shaft coupling on rear of shaft

T. Install parts to clutch in the following order:

  1. Flat washer

  2. Loading spring

  3. Flat washer

  4. Release bearing

    (NOTE: Place long sleeve end forward.)

  5. Release lever

    (NOTE: Place channel flanges toward rear.)

  6. Cushion spring

JOB SHEET #2

U. Install coiled spring pin through shaft

(NOTE: Install in second hole from shaft front end.)

V. Install rear pressure plate on shaft so that slots in hub engage pin

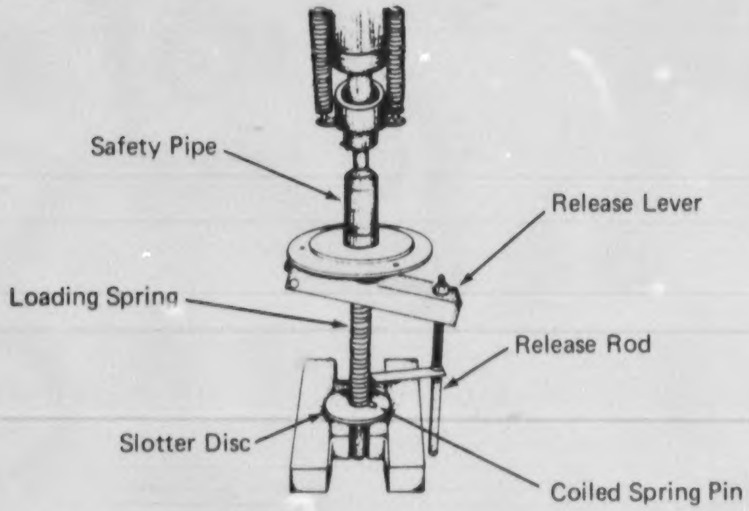
W. Install the driven disc and locating pressure plate

X. Align pin holes of the shaft and the locating pressure plate hub and install coiled spring pin

Y. Lubricate shaft in the area of release bearing with chassis grease

Z. Place assembly in a press (Figure 2)

FIGURE 2


Safety Pipe
Release Lever
Loading Spring
Release Rod
Slotter Disc
Coiled Spring Pin

AA. Align clutch driven disc with pin holes in shaft

BB. Compress loading spring

CC. Install coiled spring pin

DD. Remove assembly from press

EE. Install clutch shaft and clutch assembly

FF. Connect clutch shaft coupling at rear

GG. Connect clutch release linkage

JOB SHEET #2

HH. Move engine rearward

(NOTE: Align pins on drive plate to holes in driven disc as engine is moved into mounting position.)

II. Install bolts holding engine to frame and torque to specifications

JJ. Connect battery cable

KK. Adjust clutch according to specifications in appropriate service manual

CLUTCHES
UNIT I

NAME ____________________

TEST

1. List two types of clutches used on lawn and garden equipment.

   a.

   b.

2. Describe the operation of a belt tension idler clutch.

3. Describe the operation of a plate clutch.

4. Match the types of belt damage on the right to the probable causes.

______a. Bent or chipped pulley sidewall

______b. Overtension

______c. Excessive pulley sidewall wear

______d. Undertension

______e. Incorrect belt size or type installed

1. Rapid belt wear
2. Slipping and burning belt
3. Excessive sidewall wear
4. Cut or broken belts
5. Stretched or broken cords

5. Demonstrate the ability to:

a. Inspect and adjust a belt tension idler clutch.

b. Disassemble, inspect, and reassemble a plate clutch.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

CLUTCHES
UNIT I

ANSWERS TO TEST

1. a. Belt tension idler
   b. Plate
2. Description should include:
   a. Operator depresses clutch pedal
   b. Motion transmitted through mechanical linkage connecting pedal to idler pulley
   c. Pedal action overcomes engaging spring tension
   d. No power transmitted when belt is not under tension
   e. Operator releases pedal
   f. Engaging spring presses idler pulley against belt
   g. Power is transmitted when belt is under tension
3. Description should include:
   a. Operator depresses clutch pedal
   b. Pedal action overcomes spring tension
   c. Pressure plates and clutch disc separate to interrupt power flow
   d. Operator releases clutch pedal
   e. Spring tension compresses pressure plates and clutch disc
   f. Friction between plates and disc causes power to flow
4. a. 4
   b. 5
   c. 1
   d. 2
   e. 3
5. Performance skills evaluated to the satisfaction of the instructor

2-SPEED TRANSMISSION
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms associated with a 2-speed transmission to the correct definitions. The student should also be able to identify major parts, disassemble, inspect, service and reassemble a 2-speed transmission. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with the 2-speed transmission to the correct definitions.
2. Identify the major parts of the 2-speed transmission.
3. List seven maintenance procedures in the drive line.
4. Demonstrate the ability to disassemble, inspect and service, assemble and test a 2-speed transmission.

2-SPEED TRANSMISSION
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Make transparency.

  D. Discuss unit and specific objectives.

  E. Discuss information and job sheet.

  F. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Complete job sheet.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency master: TM 1--Major Parts of a 2-Speed Transmission

  D. Job sheet: Job Sheet #1--Disassemble, Inspect and Service, and Reassemble a 2-speed Transmission

  E. Test

  F. Answers to test

II. References

  A. *Small Tractor Service Manual. Vol. 2.* Kansas City, Missouri: Technical Publication Division/Intertec Publishing Co., 1975.

  B. *Peerless Mechanic's Manual.* Grafton, Wisconsin: Engine Division/ Peerless.

2-SPEED TRANSMISSION
UNIT I

INFORMATION SHEET

I. Terms and definitions

A. Drive axle--A shaft which connects the wheel or hub to the differential unit and transmits force to the wheels

(NOTE: Sometimes axle refers to the differential and axle combination and the term transaxle.)

B. Oil seal, single lip--An oil seal with one sealing surface to either prevent entrance of foreign matter or prevent leakage of lubricant

C. Woodruff key--A small half moon shaped piece of metal inserted between the shaft and hub to prevent rotating movement

D. Bushing--A removable sleeve type liner performing as a bearing

E. Gear ratio--Number of revolutions made by a driving gear as compared to the number of revolutions made by a driven gear of different size

Example: If the drive gear makes three revolutions while the other gear makes one revolution, the gear ratio is 3 to 1

F. Shifter lug--Lugs which can be moved as desired to engage or disengage similar collars

G. Shouldered key--Metal piece inserted between shaft and hub to prevent rotating movement.

(NOTE: That portion inserted into the shaft keyway is smaller than the portion above keyway.)

H. Shift fork--A mechanical arm which moves on a rod to position the shifter gear at an exact spot axially along the shifter shaft

II. Major parts of the 2-speed transmission (Transparency 1)

A. Case half

B. Bushing

C. Cover half

D. Shifter rod, fork, and lever

E. Input shaft

F. Output shaft (axle)

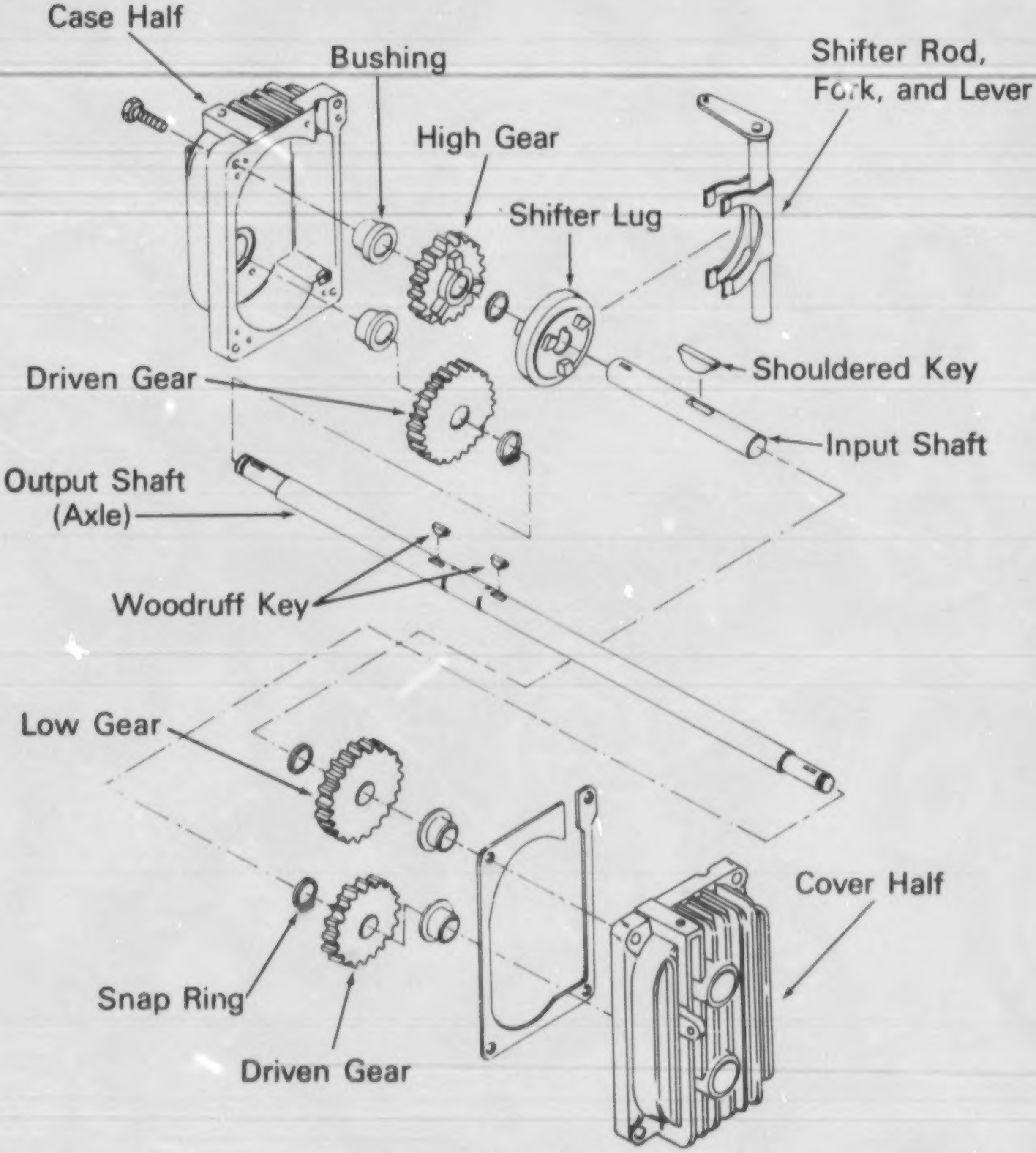
INFORMATION SHEET

- G. Shifter lug
- H. Shouldered key
- I. Woodruff key
- J. Driven gear
- K. High gear
- L. Low gear
- M. Driven gear

III. Maintenance procedures in the drive line

- A. Check chain for correct chain tension
- B. Check for loose drive belts
- C. Check for loose or lost set screw and/or sheared keys in drive and driven pulleys
- D. Check for oil leaks
- E. Check chain sprockets, axle, and transmission output shaft
- F. Check lubricant level
- G. Check chain for cleanliness and binding

Major Parts of a 2-Speed Transmission


Case Half
Bushing
High Gear
Shifter Rod, Fork, and Lever
Shifter Lug
Shouldered Key
Driven Gear
Input Shaft
Output Shaft (Axle)
Woodruff Key
Low Gear
Cover Half
Snap Ring
Driven Gear

2-SPEED TRANSMISSION
UNIT I

JOB SHEET #1--DISASSEMBLE, INSPECT AND SERVICE, ASSEMBLE, AND TEST A 2-SPEED TRANSMISSION

I. Tools and materials

A. Hand tool assortment

B. Bushing remover and installer tool

C. Snap ring

D. Manufacturer's recommended lubricant

E. Measuring cup

F. Cleaning solvent

G. Parts brush

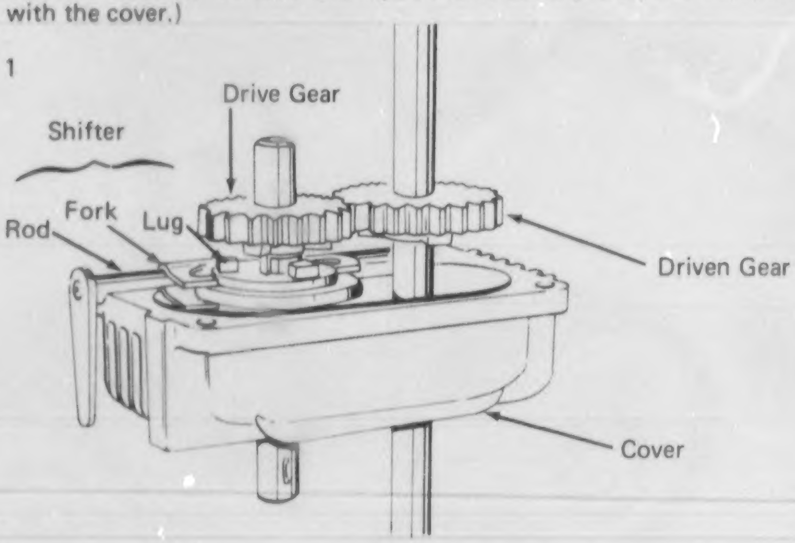
II. Procedure

A. Disassemble 2-speed transmission

1. Disassemble any attached parts such as pulleys or sprockets
2. Remove snap ring from input shaft
3. Remove the cap screws retaining the housing halves
4. Lift the case from the cover of the transmission (Figure 1)

   (NOTE: Press on the axle and input shafts to keep the parts remaining with the cover.)

FIGURE 1



JOB SHEET #1

5. Lift out the axle and gears

   (NOTE: The axle extensions from the gears are of different lengths.)

6. Remove the input shaft, drive lug and gears, and shifter as a unit; then separate parts

7. Clean all parts in solvent

8. Remove and install bushings if necessary

   (NOTE: A special bushing driver and installer will be needed for this step. Check with service manual.)

B. Inspect and service a 2-speed transmission

1. Check axle ends for worn grooves

2. Check gears for worn teeth or lugs

3. Replace snap rings, thrust washers and gasket

4. Check case and cover for cracks, or for stripped threads

C. Assemble a 2-speed transmission

1. Position snap rings and key on axle

2. Install low gear to short side of axle and high gear to the longer side

3. Coat the bushings in the case and cover with manufacturer's recommended lubricant

4. Press the shouldered key into the larger keyway on input shaft

5. Slide the shifter lug onto the shaft over the key

6. Position thrust washer on each side of the key

7. Install the remaining driven gear on the woodruff keyway side of the shaft and the low gear on the smooth side of the shaft

8. Fit the shifter forks over the flange of the shifter lug

   (NOTE: Hold the input shaft so that the other parts stay in their correct position.)

9. Install the assembly into the unit cover

   (NOTE: Woodruff key slot goes through the upper bushing and the shifter rod lays in its recesses at the top and bottom of the cover.)

JOB SHEET #1

10. Insert the short axle extension through the lower bushing on the cover

11. Coat the gears and shafts with manufacturer's recommended lubricant

12. Install new gasket and cover

    (NOTE: Check service manual for cap screw's torque.)

D. Test a 2-speed transmission

   1. Turn input and output shafts to insure that they are free from binding

   2. Move the shifter lever to low, then turn input shaft; output should turn slowly

   3. Move the shifter lever to high then turn input shaft; output should turn faster

   4. Check for seal around gasket surfaces

2-SPEED TRANSMISSION
UNIT I

NAME ________________________________

TEST

1. Match the terms on the right to the correct definitions.

______a. Number of revolutions made by a driving gear as compared to the number of revolutions made by a driven gear of different size

______b. Lugs which can be moved as desired to engage or disengage similar collars

______c. A shaft which connects the wheel or hub to the differential unit and transmits force to the wheels

______d. A small half moon shaped piece of metal inserted between the shaft and hub to prevent rotating movement

______e. A removable sleeve type liner performing as a bearing

______f. An oil seal with one sealing surface to either prevent entrance of foreign matter or prevent leakage of lubricant

______g. A mechanical arm which moves on a rod to position the shifter gear at an exact spot axially along the shifter shaft

______h. Metal piece inserted between shaft and hub to prevent rotating movement

1. Drive axle
2. Oil seal, single lip
3. Woodruff key
4. Bushing
5. Gear ratio
6. Shifter lug
7. Shouldered key
8. Shift fork

2. Identify the major parts of the 2-speed transmission.

a.

b.

c.

d.

e.

f.

g.

h.

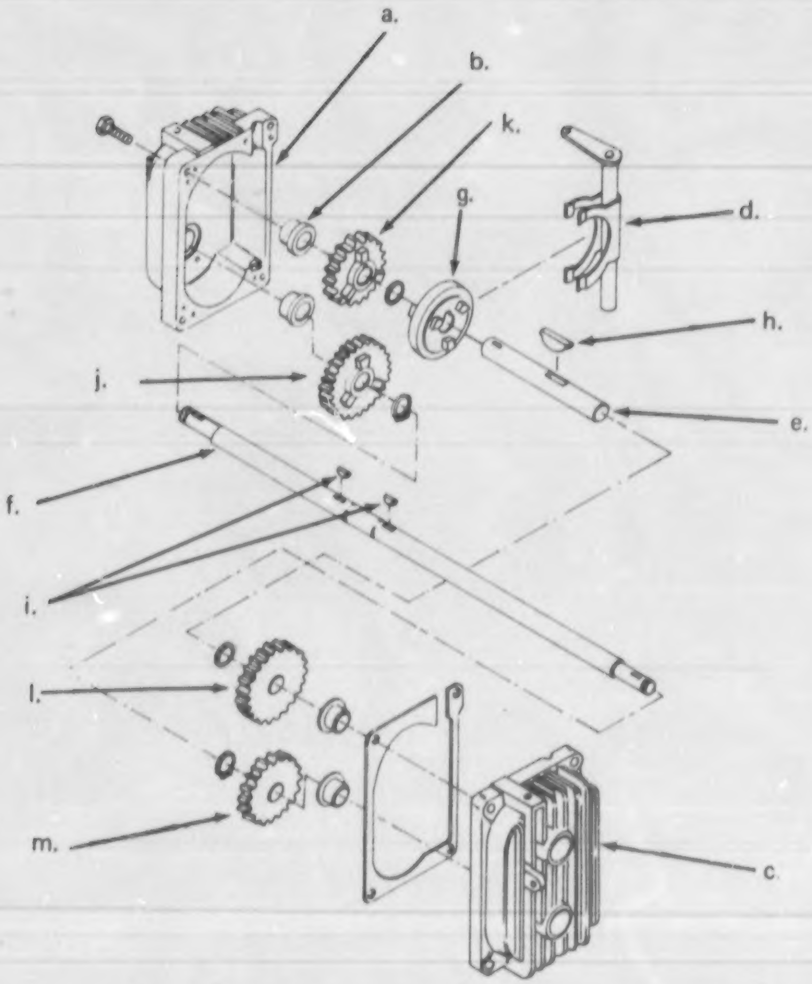
i.

j.

k.

l.

m.


a.
b.
k.
g.
d.
h.
j.
e.
f.
i.
l.
m.
c.

3. List seven maintenance procedures in the drive line.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

4. Demonstrate the ability to disassemble, inspect and service, assemble and test a 2-speed transmission.

2-SPEED TRANSMISSION
UNIT I

ANSWERS TO TEST

1. a. 5
   b. 6
   c. 1
   d. 3
   e. 4
   f. 2
   g. 8
   h. 7

2. a. Case half
   b. Bushing
   c. Cover half
   d. Shifter rod, fork, and lever
   e. Input shaft
   f. Output shaft (axle)
   g. Shifter lug
   h. Woodruff key
   i. Shouldered key
   j. Driven gear
   k. High gear
   l. Low gear
   m. Driven gear

3. a. Check chain for correct chain tension
    b. Check for loose drive belts
    c. Check for oil leaks
    d. Check chain sprockets, axle, and transmission output shaft
    e. Check lubricant level
    f. Check chain for cleanliness and binding
    g. Check for loose or lost set screw and/or sheared keys in drive and driven pulleys
4. Performance skills evaluated to the satisfaction of the instructor.

3-SPEED TRANSMISSIONS
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms associated with 3-speed transmissions to the correct definitions. The student should also be able to identify major parts, disassemble, inspect, service and reassemble a 3-speed transmission. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with the 3-speed transmission to the correct definitions.
2. Identify the major parts of the 3-speed transmission.
3. Identify parts of the shift lever assembly.
4. Demonstrate the ability to:
   a. Disassemble and reassemble a shift lever assembly.
   b. Disassemble, inspect, and service a 3-speed transmission.
   c. Reassemble a 3-speed transmission.

3-SPEED TRANSMISSION
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Major Parts of a 3-Speed Transmission

      2. TM 2--Parts of the Shift Lever Assembly

   D. Job sheets

      1. Job Sheet #1--Disassemble and Reassemble a Shift Lever Assembly

      2. Job Sheet #2--Disassemble, Inspect, and Service a 3-Speed Transmission

      3. Job Sheet #3--Reassemble a 3-Speed Transmission

E. Test

F. Answers to test

II. References:

A. *Small Tractor Service Manual*. Vol. 2. Kansas City, Missouri: Technical Publications Division/Intertec Publishing Co., 1975.

B. *Peerless Mechanic's Manual*. Grafton, Wisconsin: Engine Division/Peerless.

3-SPEED TRANSMISSION
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Shift fork--A mechanical arm which moves on a rod to position the shifter gear at an exact spot axially along the shifter shaft

B. Model number--Identifying number of a unit which will permit selection of the proper parts to repair that unit

C. Shift lever--The lever by which the operator manually changes the shifter gears to vary reduction speed ratios in the transmission

(NOTE: The configuration of the lever is variable and is often the reason for a unit being a particular model.)

D. Shift housing--The housing which retains the shift lever and when installed on the transmission case, both the lever and the housing are in a definite position relative to the shifter forks

E. Reverse idler gear--A gear added to the gear train so that in mesh, it reverses the direction of all gears driven after it

F. Bevel--Roundness of the meshing sides of gear teeth to allow easy shifting

G. Dowel pin--Alignment pin to align the case and cover and other parts in a transmission

(NOTE: Failure to install dowel pins first will usually lead to a unit that binds after assembly.)

H. Quad ring seal--A seal with two external and two internal sealing lips

I. Bevel gear--A gear with teeth ground on a diagonal so that when it meshes with a second bevel gear, power is transmitted at an angle

(NOTE: If the angle is 90°, the gear is known as a miter gear.)

J. Case--That part of the unit "casing half" which contains the shift lever and input shaft openings

(NOTE: The case and the cover switch sides depending upon whether the transmission is right or left hand drive.)

K. Cover--That part of the unit "casing half" which contains the brake shaft opening

INFORMATION SHEET

L. Input shaft--That shaft which is always connected to the power source

M. Output shaft--That shaft which transfers power to the axles

N. Thrust washer--A flat polished surface performing a bearing like function between rotating surfaces

(NOTE: It also acts as a spacer between shafts and case and cover.)

O. Gear cluster--A gear assembly in mesh with the input shaft; the gears are of different sizes to change gear ratios when meshing with the shifter gears

II. Major parts of the 3-speed transmission (Transparency 1)

A. Shift fork

B. Shift rod

C. Shift stop

D. 1st and 2nd gear

E. 3rd and reverse gear

F. Reverse idler

G. Output shaft

H. Medium cluster gear

I. Small cluster gear

J. Large cluster gear

K. Pinion gear

L. Input shaft

M. Case

N. Cover

O. Bevel gear

P. Sprocket

III. Major parts of the shift lever assembly (Transparency 2)

A. Shift housing

B. Quad ring

INFORMATION SHEET

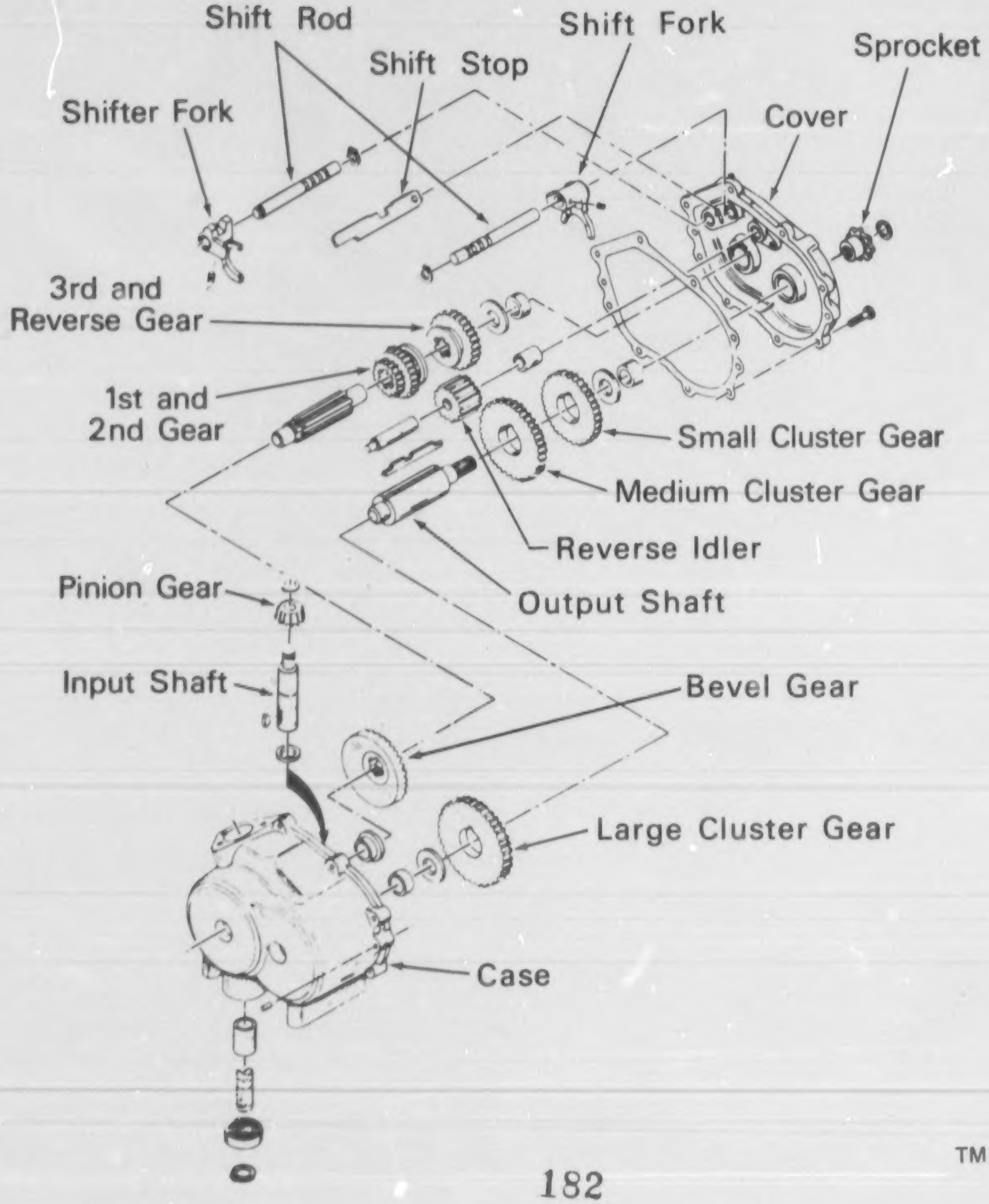
C. Roll pin

D. Shift lever keeper

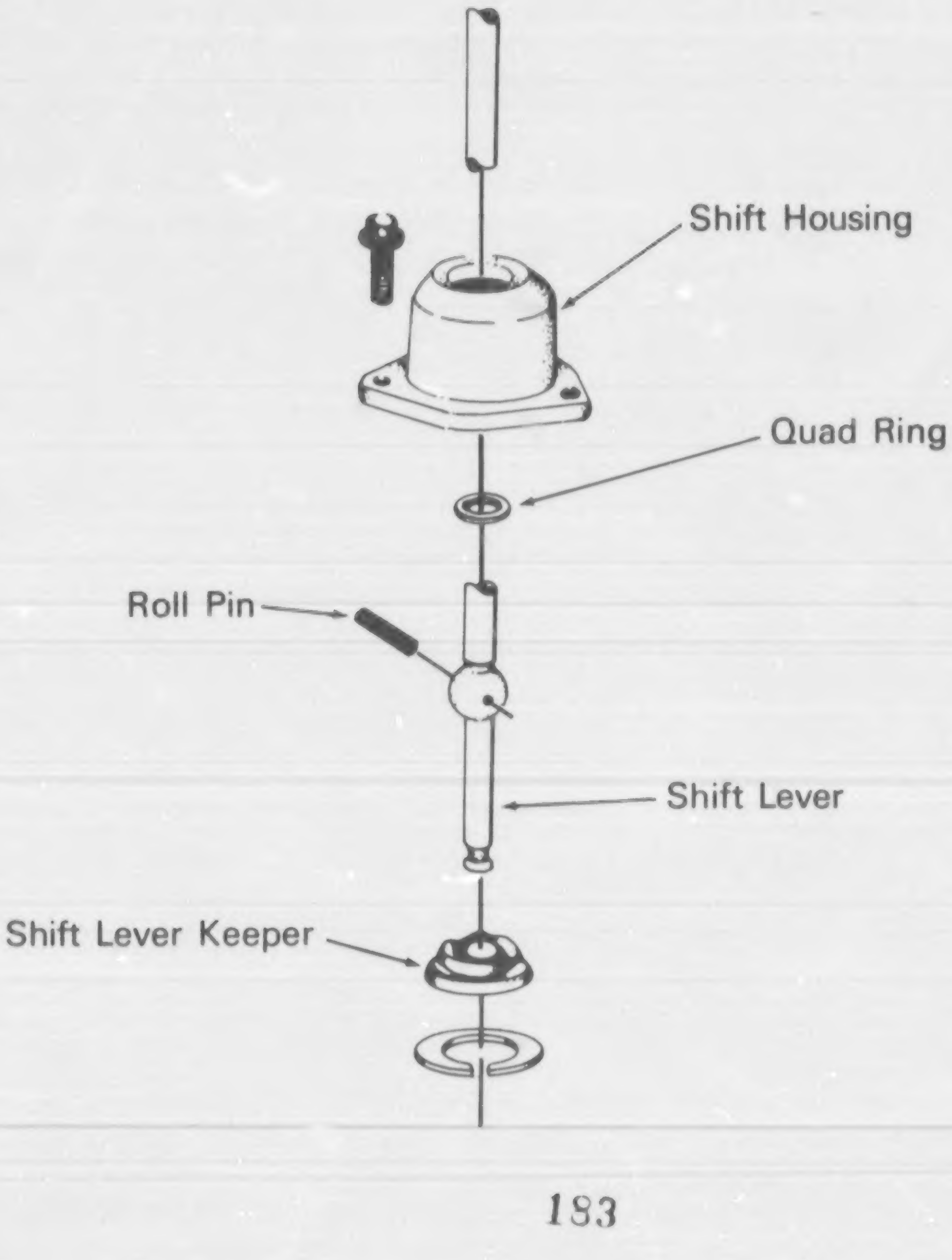
E. Snap ring

F. Shift lever

Major Parts of a 3-Speed Transmission


Shift Rod
Shift Fork
Sprocket
Shift Stop
Shifter Fork
Cover
3rd and Reverse Gear
1st and 2nd Gear
Small Cluster Gear
Medium Cluster Gear
Reverse Idler
Pinion Gear
Output Shaft
Input Shaft
Bevel Gear
Large Cluster Gear
Case

Parts of the Shift Lever Assembly


Shift Housing
Quad Ring
Roll Pin
Shift Lever
Shift Lever Keeper

3-SPEED TRANSMISSIONS
UNIT II

JOB SHEET #1--DISASSEMBLE AND REASSEMBLE A SHIFT LEVER ASSEMBLY

I. Tools and materials

  A. Safety glasses

  B. Hand tool assortment

  C. Appropriate pin punch

  D. Vise

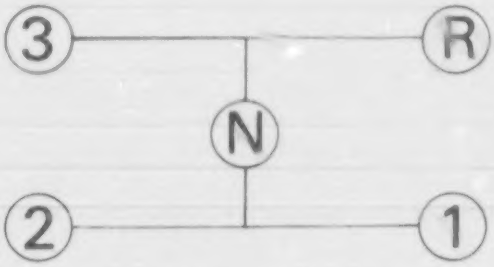
  E. Snap ring pliers

  F. Appropriate service manual

II. Procedure

  A. Move the shift lever to neutral (Figure 1)

FIGURE 1



  B. Clean around the lever housing to prevent dirt from falling into transmission

  C. Remove lever housing bolts

  D. Remove lever housing from transmission

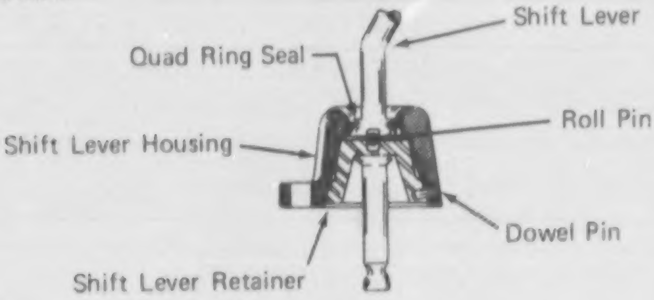
  E. Place the shift lever in a vise so that the shift lever housing is at least one inch from the top of the vise jaws

  (CAUTION: Vise jaws should be covered with wood or soft metal.)

JOB SHEET #1

F. Locate the dowel pin holding the retainer in the housing from the outside (Figure 2)

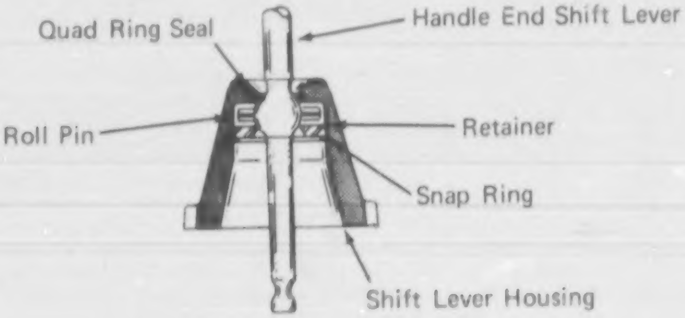
FIGURE 2


Shift Lever
Quad Ring Seal
Roll Pin
Shift Lever Housing
Dowel Pin
Shift Lever Retainer

G. Remove dowel pin with appropriate pin punch

(NOTE: Some shift lever housing retainers will have a snap ring. See Figure 3.)

FIGURE 3


Quad Ring Seal
Handle End Shift Lever
Roll Pin
Retainer
Snap Ring
Shift Lever Housing

H. Loosen the vise and disassemble the pieces

I. Remove the shift lever from the shift lever housing

(NOTE: Examine roll pin. If bent or worn, replace. See Figure 2.)

J. Check quad ring seal in the shift lever housing

K. Reassemble parts in lever housing

L. Secure parts with a new dowel pin

(NOTE: A second dowel pin is used in some assemblies for alignment. Always use a new gasket between shift lever housing and the transmission.)

3-SPEED TRANSMISSIONS
UNIT II

JOB SHEET #2--DISASSEMBLE, INSPECT AND SERVICE A 3-SPEED TRANSMISSION

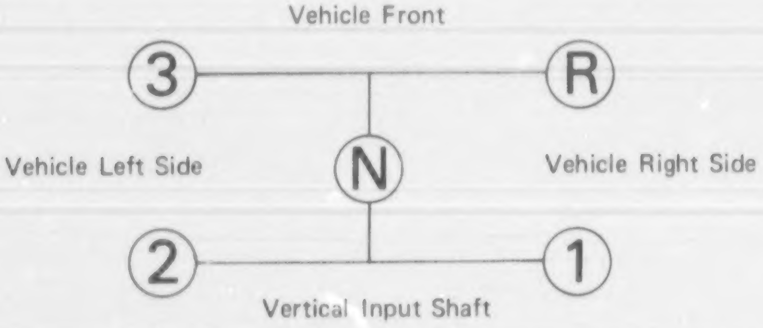
I. Tools and materials

- A. Safety glasses
- B. Hand tool assortment
- C. Appropriate pin punch
- D. Snap ring pliers
- E. Appropriate service manual
- F. Soft face hammer
- G. Seal protector
- H. Cleaning solvent
- I. Shop towels
- J. Parts brush

II. Procedure

- A. Position shift fork in neutral position (Figure 1)

FIGURE 1


Vehicle Front
3
R
Vehicle Left Side
N
Vehicle Right Side
2
1
Vertical Input Shaft

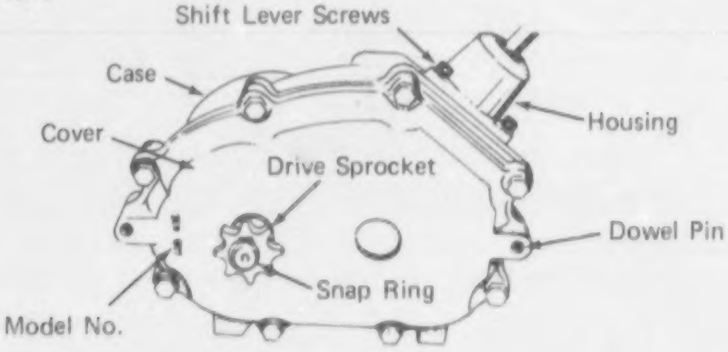
- B. Clean transmission
  1. Wash grease and dirt from housing with brush and solvent

     (NOTE: Use proper disposal techniques for dirty solvent.)
  2. Dry housing with shop towels

JOB SHEET #2

C. Remove screws holding shift lever and shift lever housing (Figure 2)

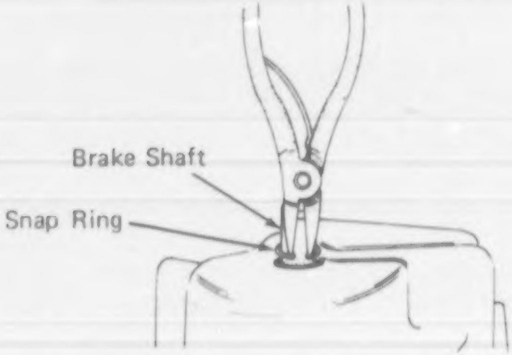
FIGURE 2


Shift Lever Screws
Case
Housing
Cover
Drive Sprocket
Dowel Pin
Snap Ring
Model No.

D. Remove shift lever housing from transmission

E. If a brake shaft is on the unit, remove snap ring from shaft (Figure 3)

FIGURE 3


Brake Shaft
Snap Ring

F. Remove snap ring holding sprocket to the output shaft (Figure 2)

G. Remove sprocket from output shaft

H. Clean output shaft of dirt and burrs

I. Remove dowel pin with pin punch (Figure 2)

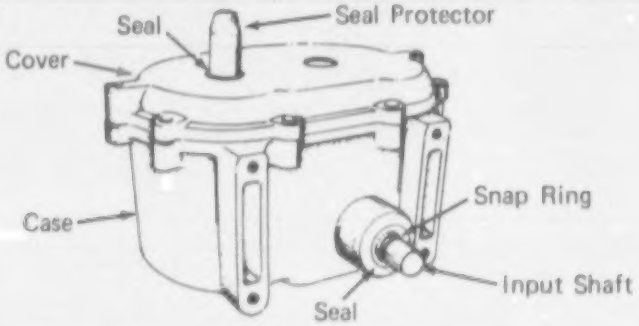
J. Remove cover screws (Figure 2)

JOB SHEET #2

K. Remove cover and cover gasket

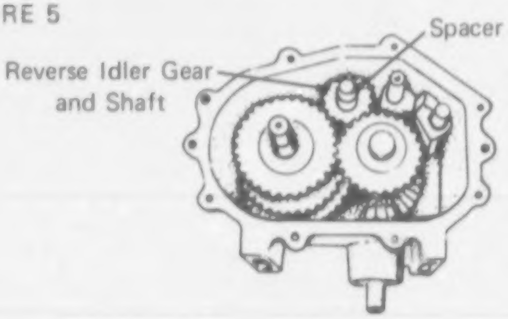
(NOTE: Install seal protector to protect the seal for output shafts on units having it. See Figure 4.)

FIGURE 4


Seal
Seal Protector
Cover
Case
Snap Ring
Input Shaft
Seal

L. Remove reverse idler gear, shaft and spacer (Figure 5)

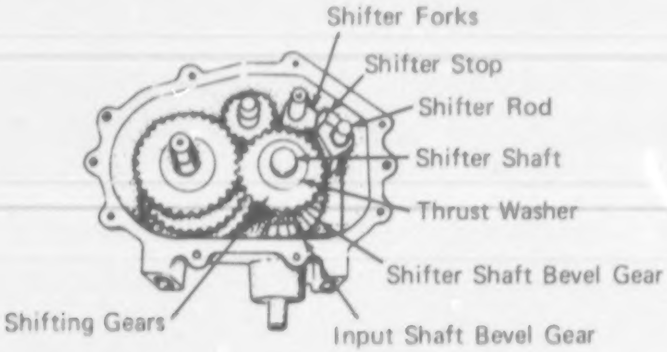
FIGURE 5


Spacer
Reverse Idler Gear and Shaft

M. Remove shift fork, gears and shaft assemblies (Figure 6)

(NOTE: Grasp shifter forks, gears and shaft and raise up while tapping shifter shaft bevel gear with a soft face hammer to separate from shaft splines.)

FIGURE 6


Shifter Forks
Shifter Stop
Shifter Rod
Shifter Shaft
Thrust Washer
Shifter Shaft Bevel Gear
Shifting Gears
Input Shaft Bevel Gear

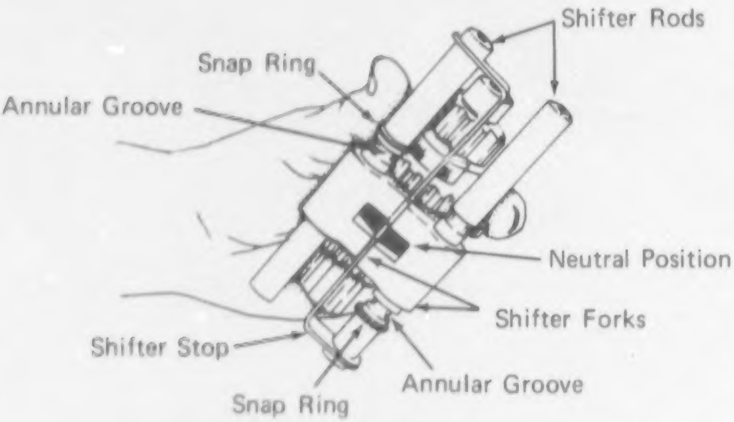
JOB SHEET #2

N. Disassemble

1. Remove the shifting assemblies from the transmission

   (NOTE: Squeeze the top end of the shifter rods. This causes a binding that retains all parts during removal.) (Figure 7)

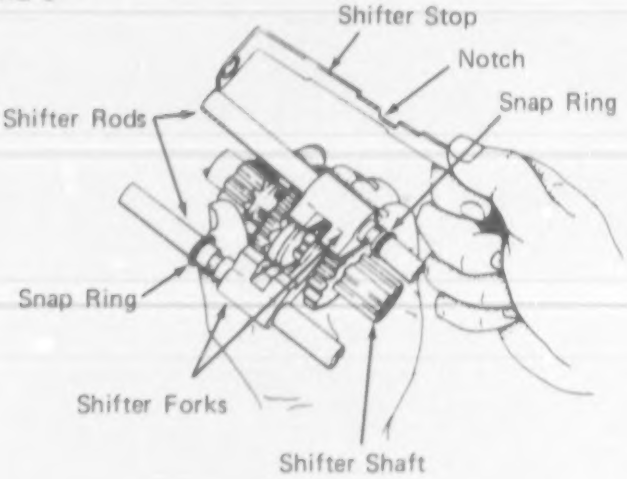
FIGURE 7


Shifter Rods
Snap Ring
Annular Groove
Neutral Position
Shifter Forks
Shifter Stop
Annular Groove
Snap Ring

2. Remove shifter stop (Figure 2)

3. Remove snap ring from shifter rods (Figure 8)

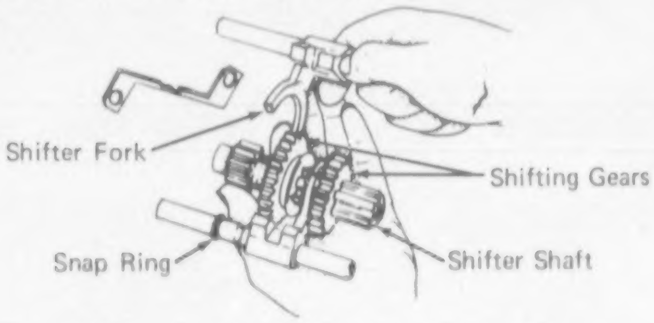
FIGURE 8


Shifter Stop
Notch
Snap Ring
Shifter Rods
Snap Ring
Shifter Forks
Shifter Shaft

JOB SHEET #2

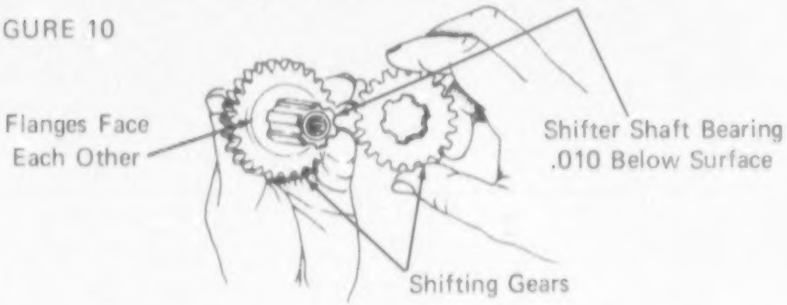
4. Remove shifter forks and rods (Figure 9)

FIGURE 9


Shifter Fork
Shifting Gears
Snap Ring
Shifter Shaft

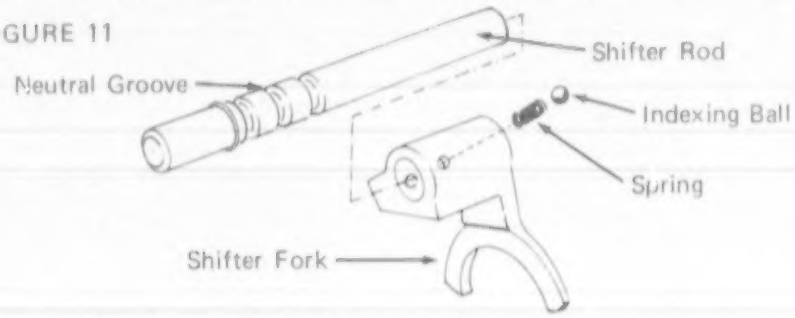
5. Remove shifting gears from shifter shaft (Figure 10)

FIGURE 10


Flanges Face
Each Other
Shifter Shaft Bearing
.010 Below Surface
Shifting Gears

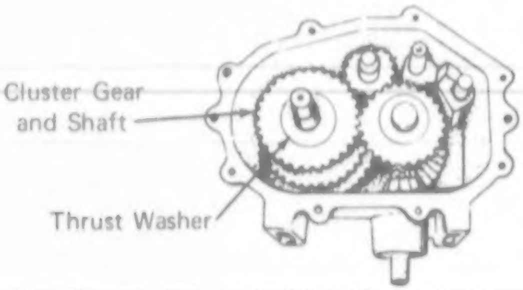
6. Remove shifter fork and indexing ball from shifter rod (Figure 11)

FIGURE 11


Shifter Rod
Neutral Groove
Indexing Ball
Spring
Shifter Fork

O. Remove cluster gears and shaft (Figure 12)

FIGURE 12

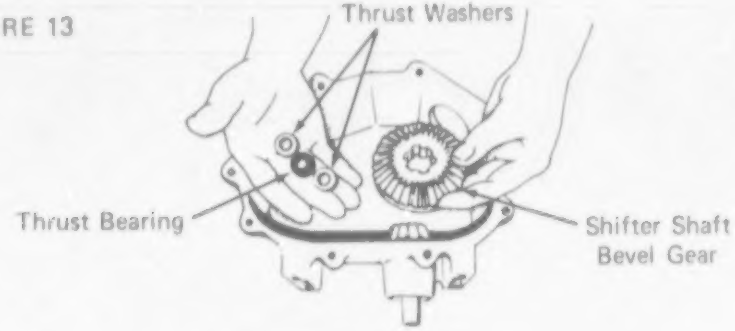

Cluster Gear
and Shaft
Thrust Washer

JOB SHEET #2

P. Remove snap ring

Q. Remove the shifter bevel gear, and the thrust bearing and washers (Figure 13)

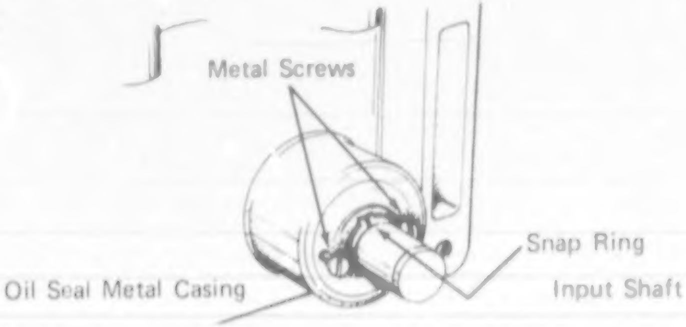
FIGURE 13


Thrust Washers
Thrust Bearing
Shifter Shaft Bevel Gear

R. Remove the input shaft seal (Figure 14)

(NOTE: Use metal screws to puncture the seal casing and lift out seal. Pry on screws with two screwdrivers.)

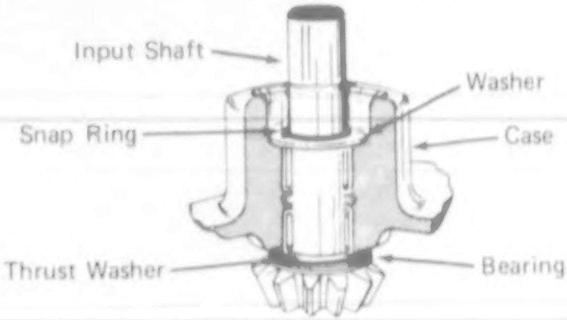
FIGURE 14


Metal Screws
Snap Ring
Oil Seal Metal Casing
Input Shaft

S. Remove the snap rings and thrust washer and press or tap the input shaft into case (Figure 15)

(NOTE: Some models will have a thrust washer and a thrust bearing.)

FIGURE 15


Input Shaft
Washer
Snap Ring
Case
Thrust Washer
Bearing

JOB SHEET #2

T. Examine all parts

(NOTE: Check gears for worn or chipped teeth and splines. Check shaft for wear or scratches and condition of snap rings grooves, splines and keyways. Examine case and cover for cracks and stripped thread condition.)

3-SPEED TRANSMISSIONS
UNIT II

JOB SHEET #3--REASSEMBLE A 3-SPEED TRANSMISSION

I. Tools and materials

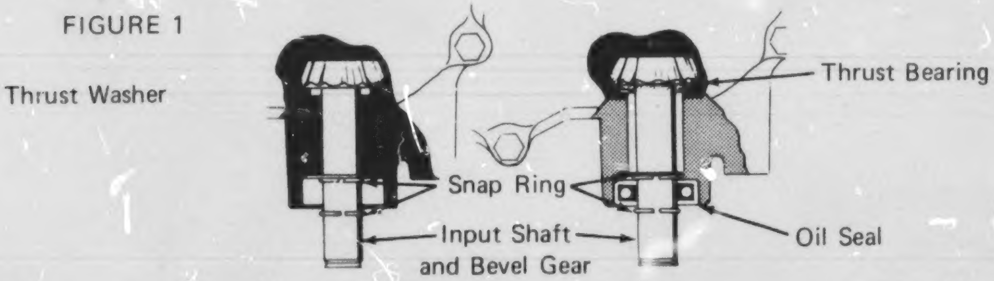
- A. Safety glasses
- B. Hand tool assortment
- C. Appropriate pin punch
- D. Snap ring pliers
- E. Appropriate service manual
- F. Manufacturer's recommended lubricant
- G. Seal driver

II. Procedure

A. Install and secure the input shaft with snap ring (Figure 1)

(NOTE: Some models will have a thrust washer and thrust bearing.)

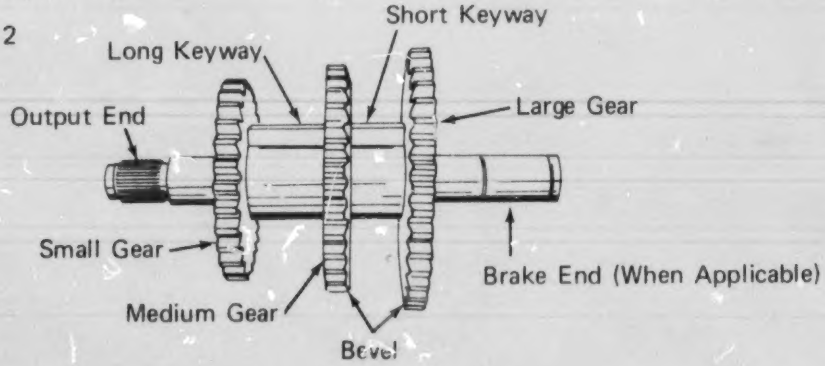
FIGURE 1


Thrust Washer
Thrust Bearing
Snap Ring
Input Shaft and Bevel Gear
Oil Seal

B. Install cluster gears and shaft with a thrust washer between the large gear and case (Figure 2)

(NOTE: The small and middle gear bevel faces down, the large gear bevel faces up.)

FIGURE 2

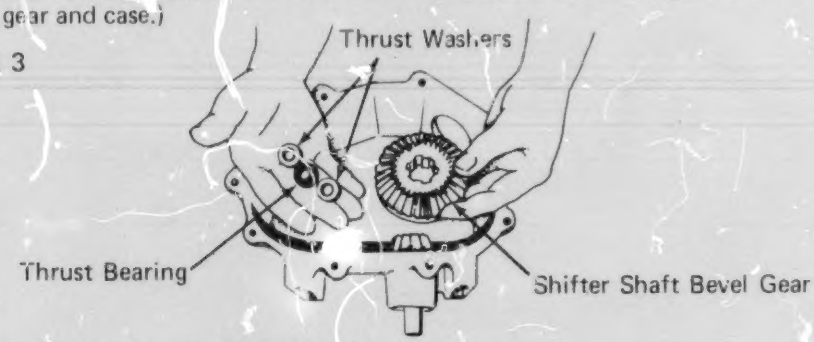

Short Keyway
Long Keyway
Output End
Large Gear
Small Gear
Brake End (When Applicable)
Medium Gear
Bevel

JOB SHEET #3

C. Install the shifter bevel gear (Figure 3)

(NOTE: On some models be sure the thrust washers and bearing are between the gear and case.)

FIGURE 3

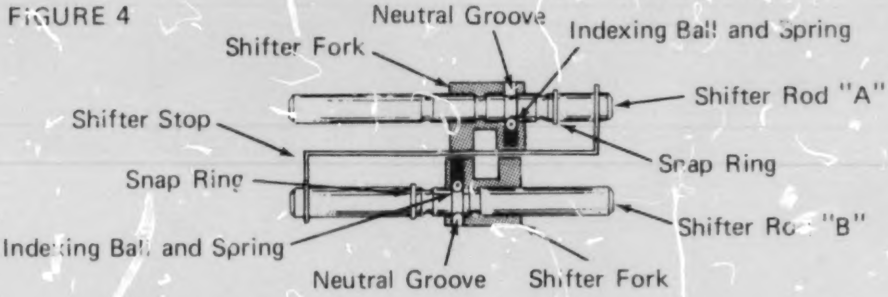

Thrust Washers
Thrust Bearing
Shifter Shaft Bevel Gear

D. Reassemble shift assembly mechanism

1. Lay the parts on the bench in the same manner as illustrated (Figure 4)

   (NOTE: Pay particular attention to the annular grooves in the shifter rods and the snap rings.)

FIGURE 4

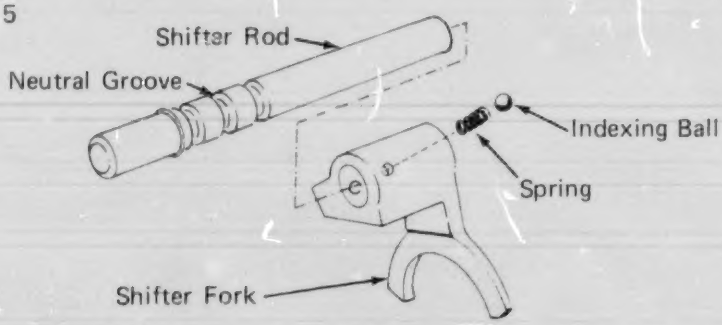

Neutral Groove
Indexing Ball and Spring
Shifter Fork
Shifter Rod "A"
Shifter Stop
Snap Ring
Snap Ring
Shifter Rod "B"
Indexing Ball and Spring
Neutral Groove
Shifter Fork

2. Install the shifter fork to the shifter rods (Figure 5)

   (NOTE: The shifter forks are interchangeable.)

3. With a punch, press the indexing ball into the hole and move the shifting fork completely onto the shifter rod.)

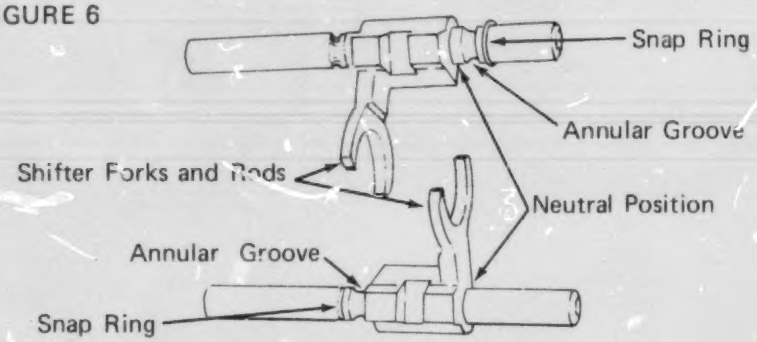
FIGURE 5


Shifter Rod
Neutral Groove
Indexing Ball
Spring
Shifter Fork

JOB SHEET #3

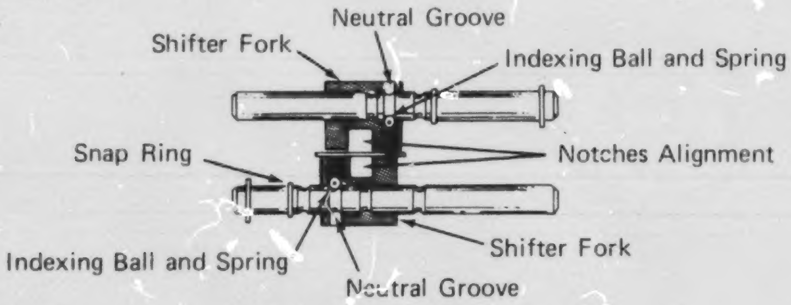
4. Move the shifting fork to the neutral position (Figure 6)

FIGURE 6


Snap Ring
Annular Groove
Shifter Forks and Rods
Neutral Position
Annular Groove
Snap Ring

(NOTE: When the shifter forks are properly assembled to the shifter rods and positioned in neutral, the ends of the notches in the shifter forks are in alignment. See Figure 7)

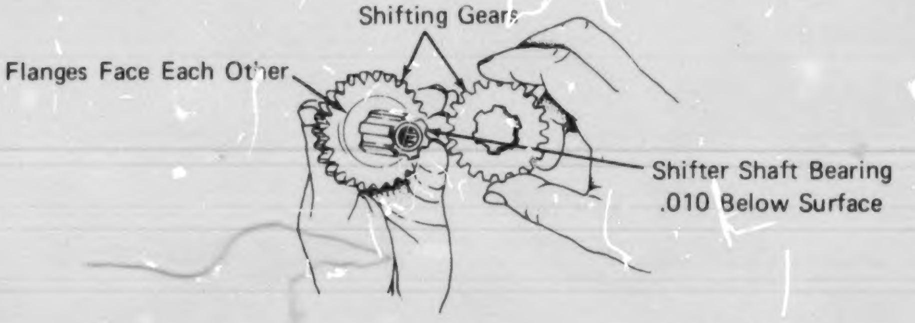
FIGURE 7


Neutral Groove
Shifter Fork
Indexing Ball and Spring
Snap Ring
Notches Alignment
Indexing Ball and Spring
Shifter Fork
Neutral Groove

5. Assemble the two flanged gears onto the shifter shaft (Figure 8)

(NOTE: The larger gear is placed on the shaft first with the flange side toward the needle bearing in the end of the shifter shaft.)

FIGURE 8

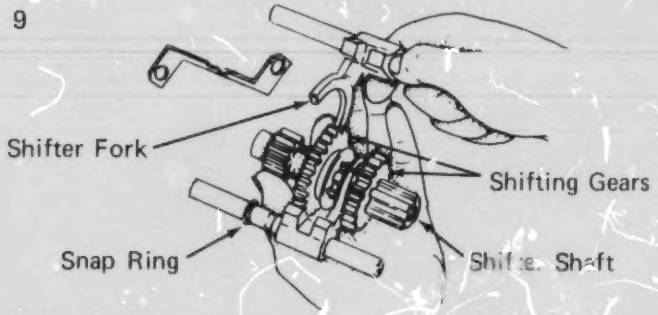

Shifting Gears
Flanges Face Each Other
Shifter Shaft Bearing
.010 Below Surface

JOB SHEET #3

6. Assemble shifter forks and rods to the flanged gears (Figure 9)

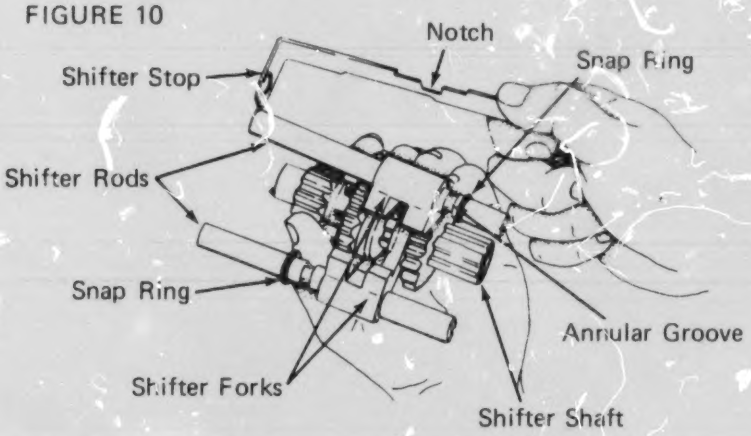
(NOTE: Hold the shifter shaft in the hand during assembly.)

FIGURE 9


Shifter Fork
Shifting Gears
Snap Ring
Shifter Shaft

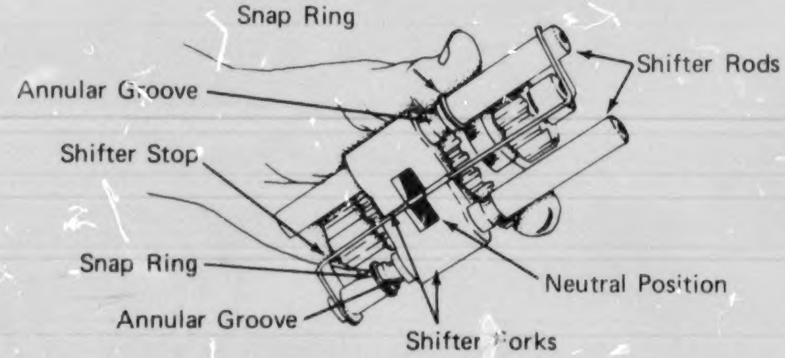
7. Install shifter stop (Figure 10)

FIGURE 10


Notch
Shifter Stop
Snap Ring
Shifter Rods
Snap Ring
Annular Groove
Shifter Forks
Shifter Shaft

(NOTE: Remember to squeeze the ends of the shifter rods to cause the assembly to bind and stay together. See Figure 11.)

FIGURE 11

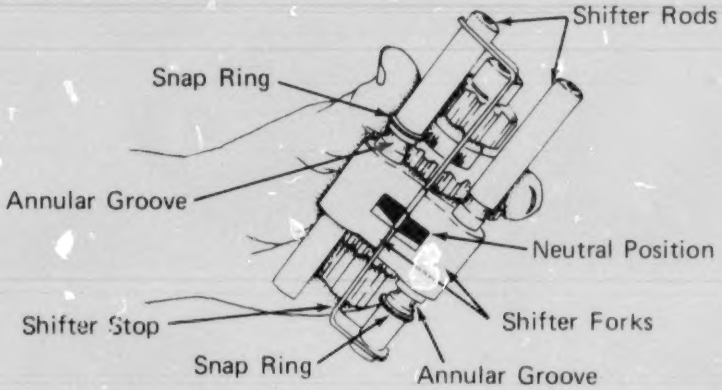

Snap Ring
Shifter Rods
Annular Groove
Shifter Stop
Snap Ring
Neutral Position
Annular Groove
Shifter Forks

JOB SHEET #3

E. Install the shift mechanism

(NOTE: The shift mechanism must be held firmly to keep parts from changing position. See Figure 12.)

FIGURE 12


Shifter Rods
Snap Ring
Annular Groove
Neutral Position
Shifter Stop
Shifter Forks
Snap Ring
Annular Groove

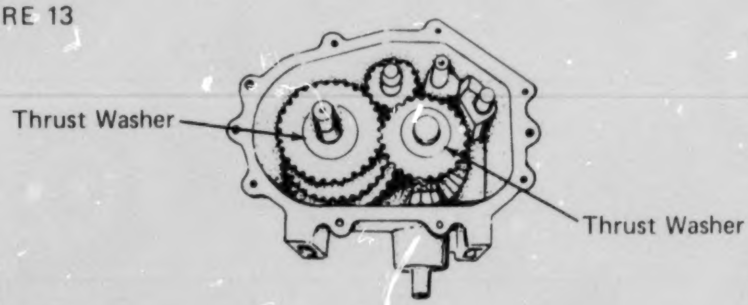
F. Install reverse idler shaft, gear and spacer

(NOTE: Install gear with bevel out toward spacer.)

G. Install washer on the cluster gear and shifter shaft (Figure 13)

(NOTE: Apply recommended quantity of manufacturer's specified lubricant.)

FIGURE 13


Thrust Washer
Thrust Washer

H. Install gasket to case

I. Install cover to case and secure by cross tightening cap screws

(NOTE: Check service manual for cap screw torque.)

(CAUTION: Do not force cover on.)

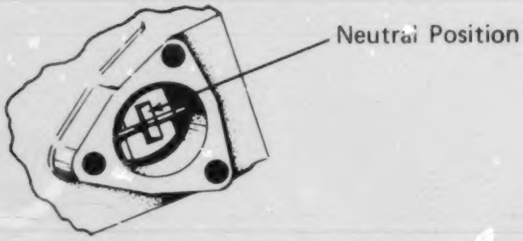
J. Install oil seals if used

JOB SHEET #3

K. Install new gasket, shift lever and housing

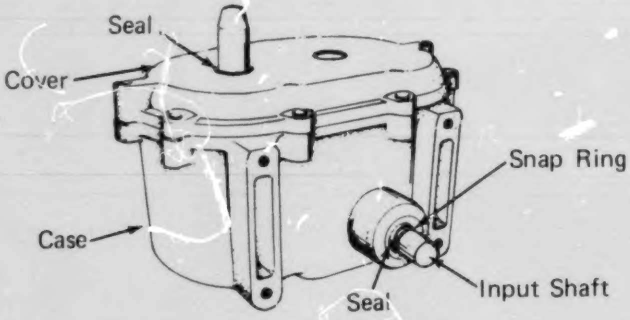
(NOTE: Place shift lever in neutral position. See Figure 14.)

FIGURE 14


Neutral Position

L. Install sprocket and snap ring on output shaft (Figure 15)

FIGURE 15


Seal
Cover
Snap Ring
Case
Seal
Input Shaft

M. Turn input shaft to check for binding

N. Check for correct shifting pattern

O. Test unit

(NOTE: With the units in neutral, turn the output sprocket. The input shaft should not turn. With unit in any gear, input shaft turns.)

3-SPEED TRANSMISSIONS
UNIT II

NAME ____________________________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. Identifying number of a unit which will permit selection of the proper parts to repair that unit

_____b. The housing which retains the shift lever and when installed on the the transmission case, both the lever and the housing are in a definite position relative to the shifter forks

_____c. Roundness of the meshing sides of gear teeth to allow easy shifting

_____d. A seal with two external and two internal sealing lips

_____e. That part of the unit "casing half" which contains the brake shaft opening

_____f. That shaft which is always connected to the power source

_____g. A gear assembly in mesh with the input shaft; the gears are of different sizes to change gear ratios when meshing with the shifter gears

_____h. A flat polished surface performing a bearing like function between rotating surfaces

_____i. That shaft which transfers power to the axles

_____j. That part of the unit "casing half" which contains the shift lever and input shaft openings

_____k. A gear with teeth ground on a diagonal so that when it meshes with a second bevel gear, power is transmitted at an angle

_____l. Alignment pin to align the case and cover and other parts in a transmission

1. Gear cluster
2. Output shaft
3. Cover
4. Bevel gear
5. Dowel pin
6. Reverse idler gear
7. Shift lever
8. Shift fork
9. Model number
10. Shift housing
11. Bevel
12. Quad ring seal
13. Case
14. Input shaft
15. Thrust washer

_____m. A gear added to the gear train so that in mesh, it reverses the direction of all gears driven after it

_____n. The lever by which the operator manually changes the shifter gears to vary reduction speed ratios in the transmission

_____o. A mechanical arm which moves on a rod to position the shifter gear at an exact spot axially along the shifter shaft

2. Identify the major parts of the 3-speed transmission.

a.____________________

b.____________________

c.____________________

d.____________________

e.____________________

f.____________________

g.____________________

h.____________________

i.____________________

j.____________________

k.____________________

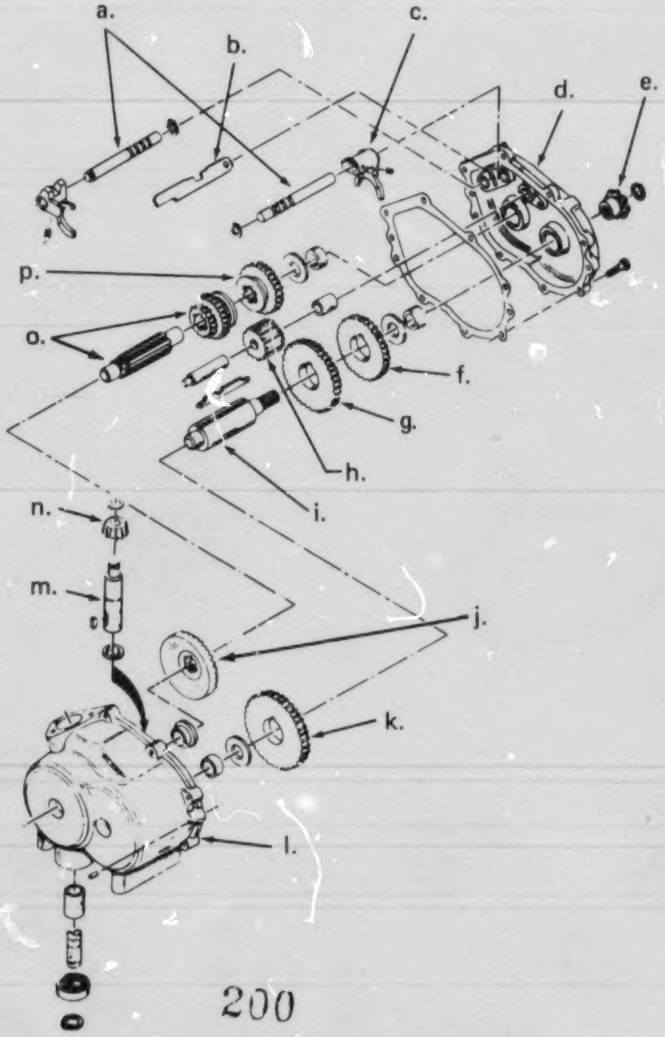
l.____________________

m.____________________

n.____________________

o.____________________

p.____________________



200

3. Identify parts of the shift lever assembly.

a.______________________________

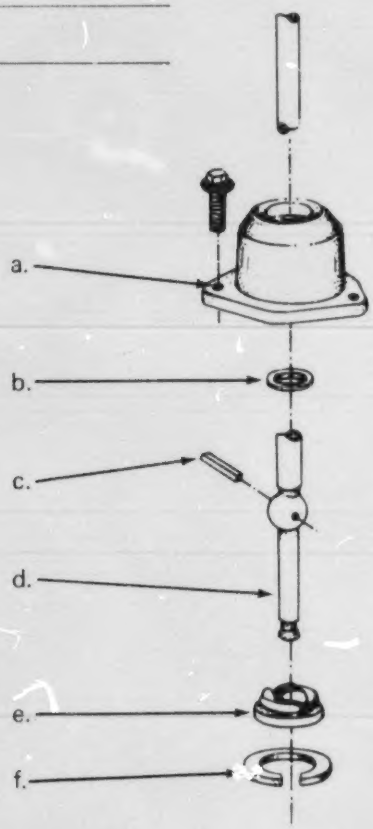
b.______________________________

c.______________________________

d.______________________________

e.______________________________

f.______________________________



4. Demonstrate the ability to:

a. Disassemble and reassemble a shift lever assembly.

b. Disassemble, inspect, and service a 3-speed transmission.

c. Reassemble a 3-speed transmission.

3-SPEED TRANSMISSIONS
UNIT II

ANSWERS TO TEST

1. a. 9
   b. 10
   c. 11
   d. 12
   e. 3
   f. 14
   g. 1
   h. 15
   i. 2
   j. 13
   k. 4
   l. 5
   m. 6
   n. 7
   o. 8

2. a. Shift rod
   b. Shift stop
   c. Shift fork
   d. Cover
   e. Sprocket
   f. Small cluster gear
   g. Medium cluster gear
   h. Reverse idler
   i. Output shaft
   j. Bevel gear
   k. Large cluster gear
   l. Case
   m. Input shaft
   n. Pinion gear
   o. 1st and 2nd gear
   p. 3rd and reverse gear

3. a. Shift housing
   b. Quad ring
   c. Roll pin
   d. Shift lever
   e. Shift lever keeper
   f. Snap ring

4. Performance skills evaluated to the satisfaction of the instructor

FOUR-SPEED TRANSAXLES
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to disassemble and reassemble a four-speed transaxle. The student should also be able to identify the parts and match terms and definitions of the four-speed transaxle. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with the four-speed transaxle to the correct definitions.
2. Identify parts of the four-speed transaxle.
3. List four common problems with four-speed transaxles.
4. Demonstrate the ability to:
    a. Disassemble and inspect a four-speed transaxle.
    b. Reassemble and test a four-speed transaxle.

FOUR-SPEED TRANSAXLES
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information and job sheets.

   F. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters: TM 1--Parts of the Four-Speed Transaxle

   D. Job sheets

      1. Job Sheet #1--Disassemble and Inspect a Four-Speed Transaxle

      2. Job Sheet #2--Reassemble and Test a Four-Speed Transaxle

   E. Test

   F. Answers to test

II. References:

A. *Small Tractor Service Manual, Volume 2.* Kansas City, Missouri: Technical Publications Division/Intertec Publishing Co., 1975.

B. *Peerless Mechanic's Manual.* Grafton, Wisconsin: Engine Division/Peerless.

FOUR-SPEED TRANSAXLES
UNIT III

INFORMATION SHEET

I. Terms and definitions

- A. Transaxle--A combination of familiar parts of a drive train; the transmission, differential, and axles, in one compact unit
- B. Axle housing--An extension of the case and cover to support the outer ends of the axles
- C. Brakeshaft--That shaft on a transaxle to which a braking system may be attached
- D. Chamfer--Diagonal milling at the corners of gear teeth to remove sharp edges

  (NOTE: This eliminates the possibility of hardened gears chewing softer metal.)
- E. Boss--A raised part or protruding part on a flat surface
- F. Spur gear--A gear having the shaft bore and teeth in a parallel plane
- G. Splines--Slots or grooves cut in a shaft or bore
- H. Differential--A mechanism at the rear axles that permits one rear wheel to turn at a different speed than the other
- I. Gears--Mechanical devices used to transmit power, or turning effort from one shaft to another

II. Parts of the four speed transaxle (Transparency 1)

- A. Carrier bearing
- B. Axle housing
- C. Axle outer bearing
- D. Transaxle case
- E. Shift fork
- F. Reverse idler gear
- G. 1st, 2nd, and reverse gear
- H. Brake and cluster shaft
- I. 3-cluster gear

INFORMATION SHEET

J. Differential carrier

K. Transaxle cover

L. Bevel pinion gear

M. Ring gear

N. 3rd and 4th gears

III. Common problems with four-speed transaxles

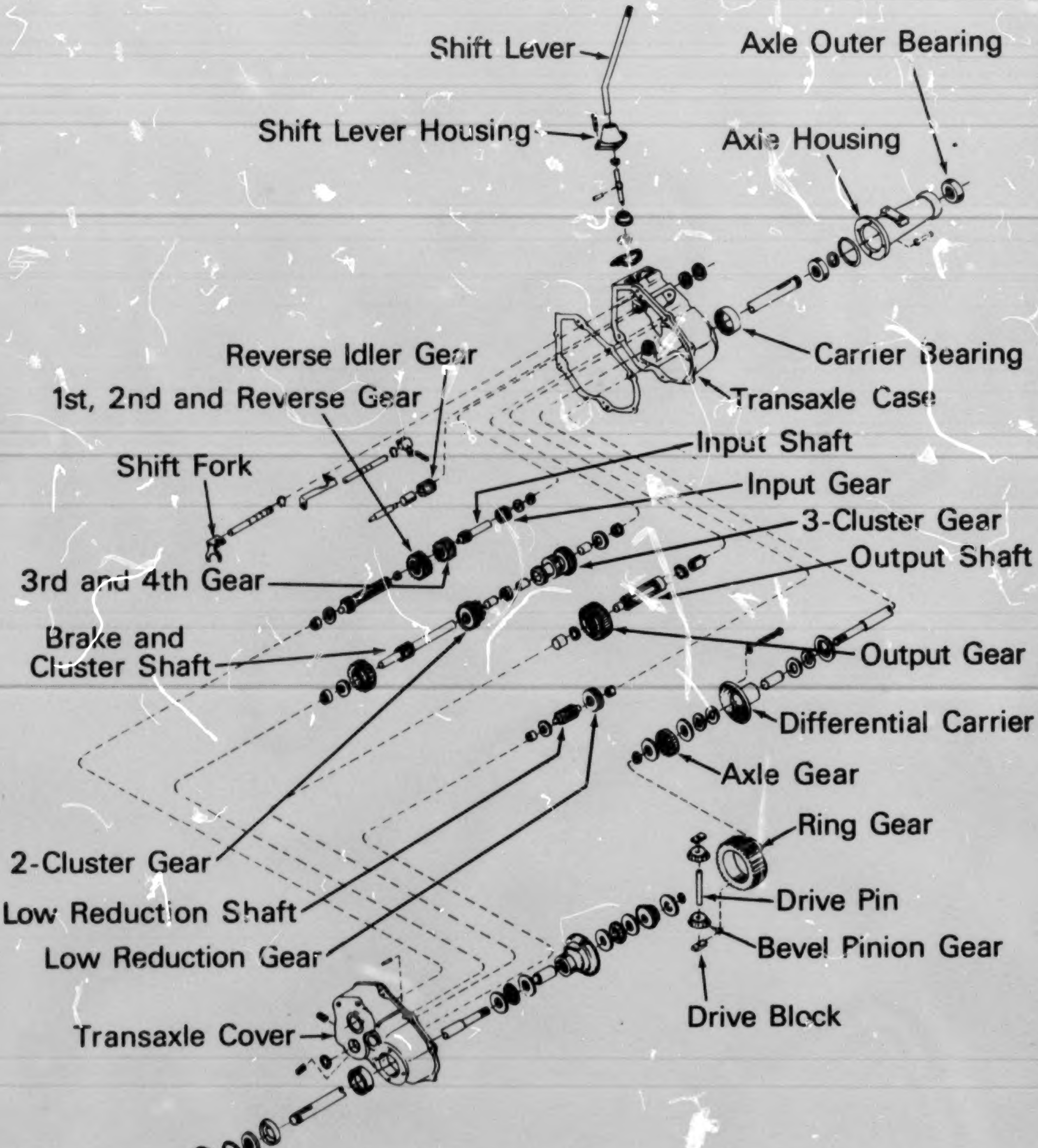
A. Unit cannot be shifted

B. Unit is noisy

C. Axles cannot be turned (same direction) with unit in neutral

D. Unit does not drive

Parts of the Four-Speed Transaxle


Shift Lever
Axle Outer Bearing
Shift Lever Housing
Axle Housing
Carrier Bearing
Reverse Idler Gear
1st, 2nd and Reverse Gear
Transaxle Case
Input Shaft
Shift Fork
Input Gear
3-Cluster Gear
3rd and 4th Gear
Output Shaft
Brake and Cluster Shaft
Output Gear
Differential Carrier
Axle Gear
Ring Gear
2-Cluster Gear
Drive Pin
Low Reduction Shaft
Bevel Pinion Gear
Low Reduction Gear
Drive Block
Transaxle Cover

FOUR-SPEED TRANSAXLES
UNIT III

JOB SHEET #1--DISASSEMBLE AND INSPECT A FOUR-SPEED TRANSAXLE

I. Tools and materials

  A. Safety glasses

  B. Hand tool assortment

  C. Snap ring pliers

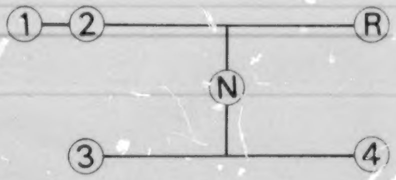
  D. Appropriate service manual

  E. Scribe

II. Procedure

  A. Position the shifter forks in neutral (Figure 1)

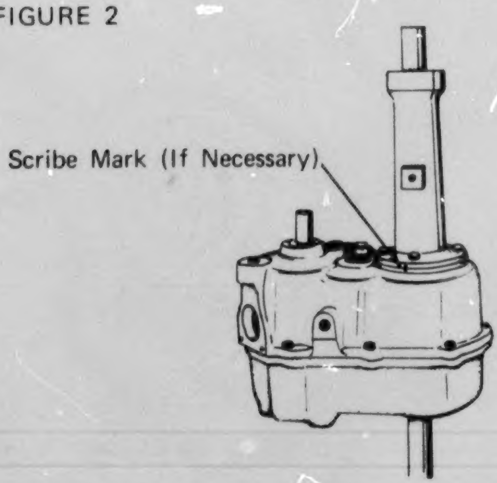
FIGURE 1



  B. Remove both axle housings (Figure 2)

  (NOTE: Scribe a mark on the axle housing, cover and case.)

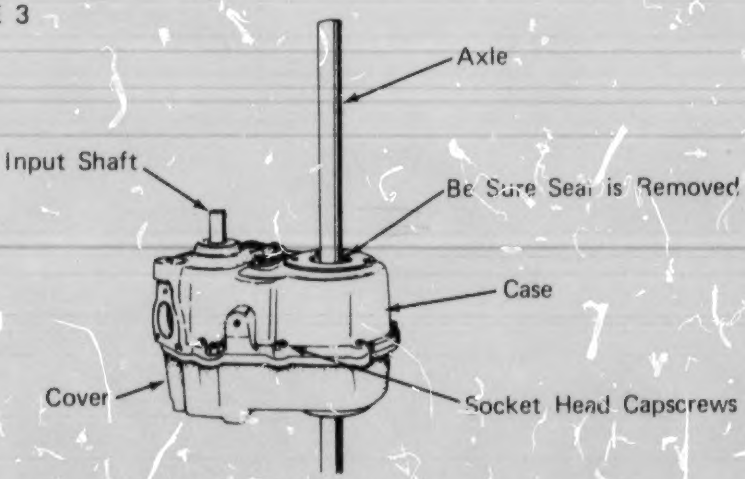
FIGURE 2



JOB SHEET #1

C. Remove the seal retainers from the case and cover (Figure 3)

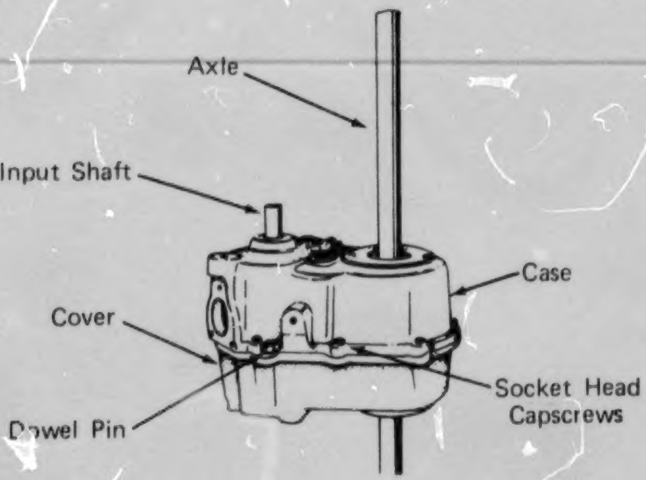
FIGURE 3


Axle
Input Shaft
Be Sure Seal is Removed
Case
Cover
Socket Head Capscrews

(NOTE: When disassembling the rest of the unit, it should be held so that it lies on the cover, properly blocked up, so that no weight rests on the brake shaft

D. Tap dowel pin into the cover and remove capscrews (Figure 4)

FIGURE 4


Axle
Input Shaft
Case
Cover
Socket Head Capscrews
Dowel Pin

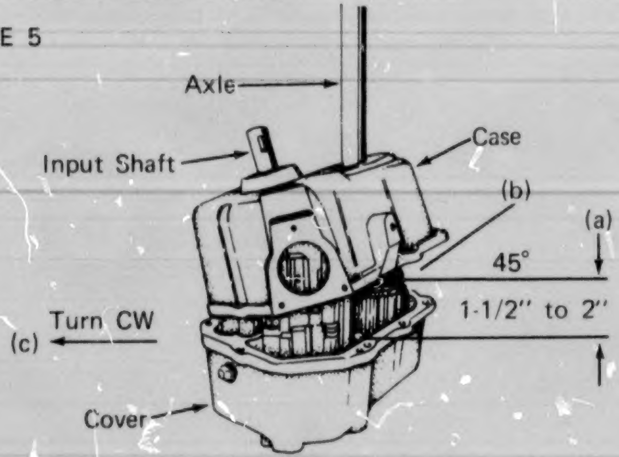
(NOTE: Place support under area to be tapped to prevent case damage.)

JOB SHEET #1

F. Separate the case from the cover (Figure 5)

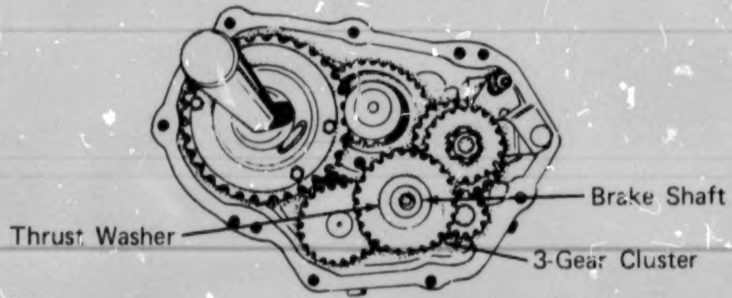
(NOTE: Lift the case 1 1/2 to 2 inches above the cover. Tilt the case so the shift rod will clear the edge. Rotate the case so that boss hidden inside will clear gears. Then lift free of the differential.)

FIGURE 5


Axle
Case
Input Shaft
(b)
(a)
45°
1-1/2" to 2"
Turn CW
(c)
Cover

G. Remove thrust washer and three gear cluster from brake shaft (Figure 6)

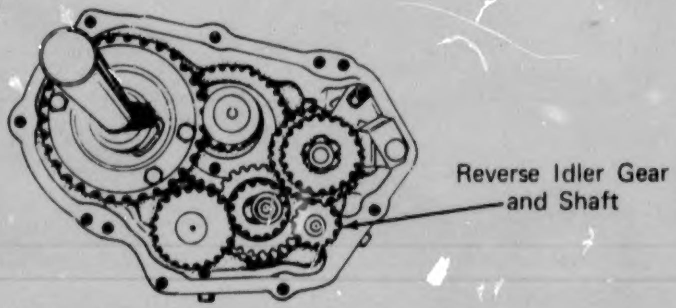
FIGURE 6


Brake Shaft
Thrust Washer
3-Gear Cluster

H. Remove the reverse idler gear, spacer, and shaft from boss in cover (Figure 7

(NOTE: The spacer goes between the gear and the gear bevels go down.

FIGURE 7

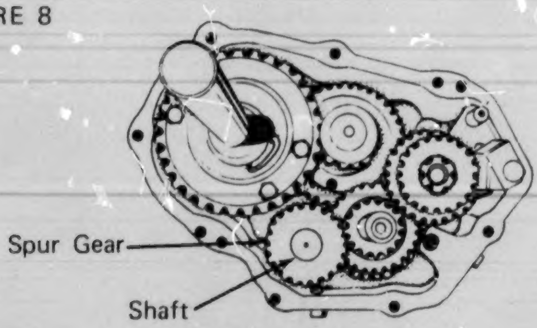

Reverse Idler Gear and Shaft

JOB SHEET #1

I. Remove the low gear and shaft, and splined spur gear (Figure 8)

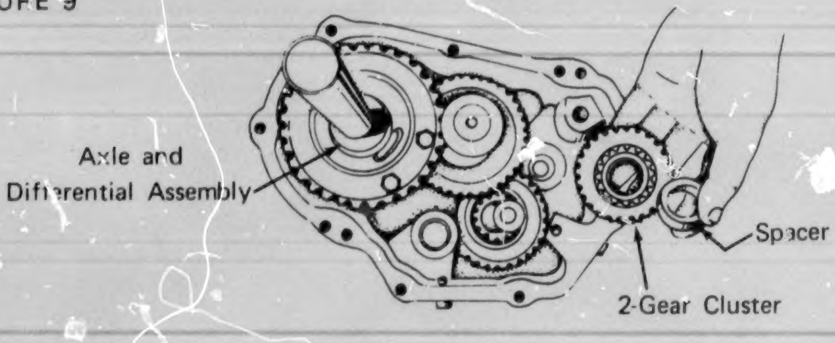
(NOTE: There is no thrust washer between the gear and case.)

FIGURE 8


Spur Gear
Shaft

J. Remove the two gear cluster and spacer from brake shaft (Figure 9)

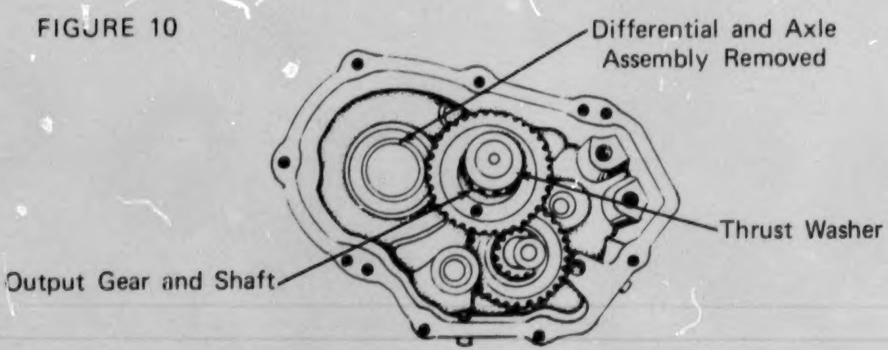
FIGURE 9


Axle and
Differential Assembly
Spacer
2-Gear Cluster

K. Lift the differential unit out of the cover (Figure 9)

L. Remove the output shaft and gear and thrust washer from each end of the shaft (Figure 10)

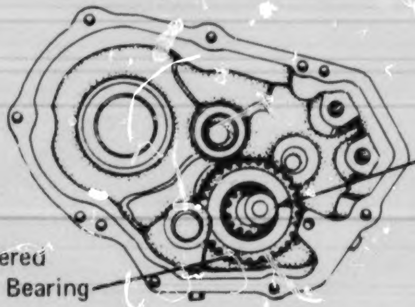
FIGURE 10


Differential and Axle
Assembly Removed
Thrust Washer
Output Gear and Shaft

JOB SHEET #1

M. Remove the brake shaft (Figure 11)

FIGURE 11


Brake Shaft
Idler Gear Chamfered Side Up, Away from Bearing

N. Check all gear bevels for galling and check face of teeth for wear due to improper shifting

(NOTE: Large shiny areas indicate excessive tooth contact and possible excessive wear.)

O. Check shafts and axles surface for rust, pitting, scratches or wear. Also check keyway, splines, threads, and grooves for wear

P. Check case and cover for cracks, stripped threads, metal chips, flat sealing surfaces and rust

Q. Check all thrust washers and spacers for wear

FOUR-SPEED TRANSAXLES
UNIT III

JOB SHEET #2--REASSEMBLE AND TEST A FOUR-SPEED TRANSAXLE

I. Tools and materials

   A. Safety glasses

   B. Hand tool assortment

   C. Snap ring plier

   D. Manufacturer's recommended lubricant

   E. Soft mallet

   F. Needle nose pliers

   G. Appropriate service manual

II. Procedure

   A. Install input shaft in case

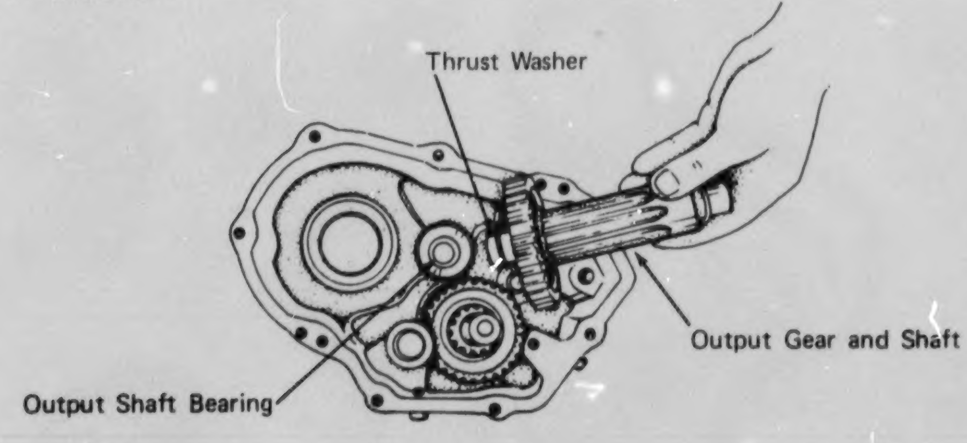
      (NOTE: Use a soft mallet to seat shaft and gear completely.)

      (CAUTION: Binding in the assembled unit can be traced to a partially installed input shaft.)

   B. Center the thrust washer on the cover brake shaft needle bearing, then install the brake shaft and gear (Figure 1)

      (NOTE: The chamfer side is away from cover.)

FIGURE 1

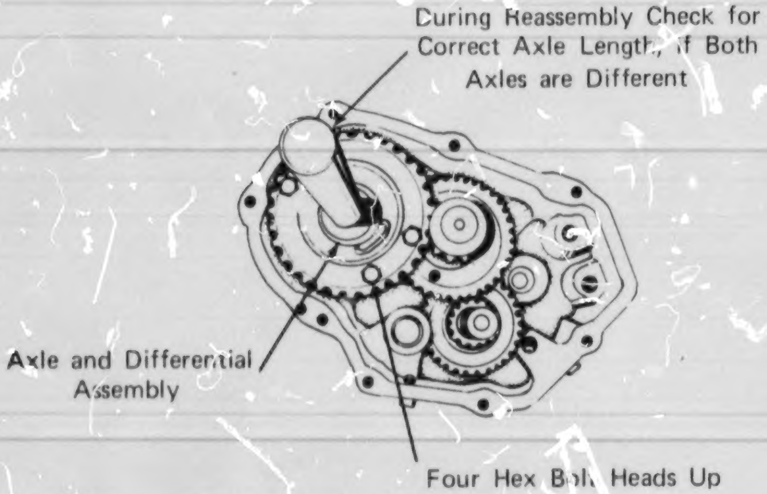


JOB SHEET #2

C. Insert the differential assembly in the cover (Figure 2)

(NOTE: The bolt heads should be away from the output gear. Check for correct axle length, if both are different.)

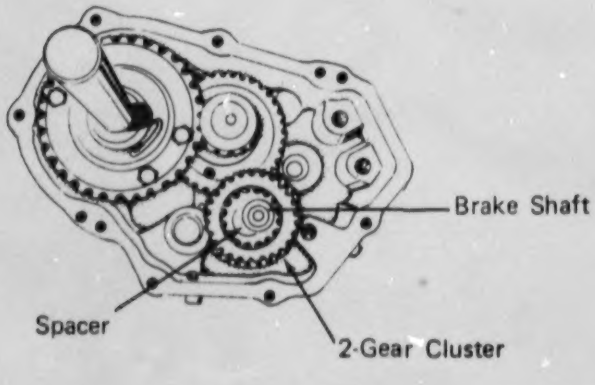
FIGURE 2


During Reassembly Check for Correct Axle Length, if Both Axles are Different
Axle and Differential Assembly
Four Hex Bolt Heads Up

D. Install the two gear cluster and spacer on the brake shaft (Figure 3)

FIGURE 3

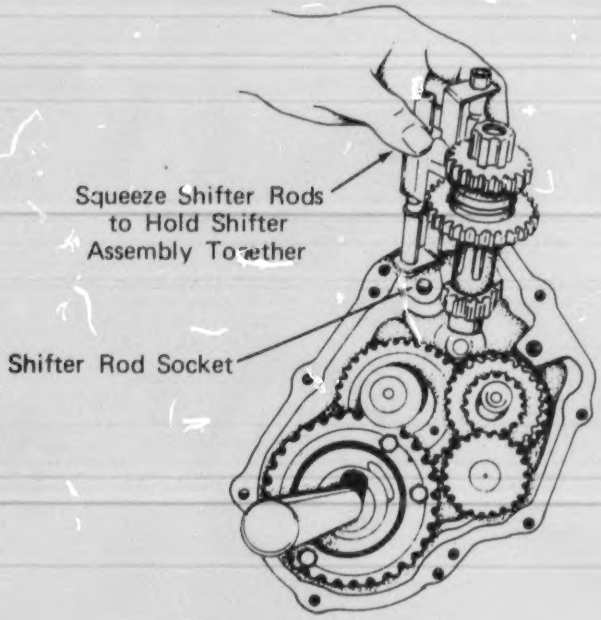
Install Differential


Brake Shaft
Spacer
2-Gear Cluster

JOB SHEET #2

E. Center thrust washer on cover shifter shaft bearing (Figure 4)

FIGURE 4

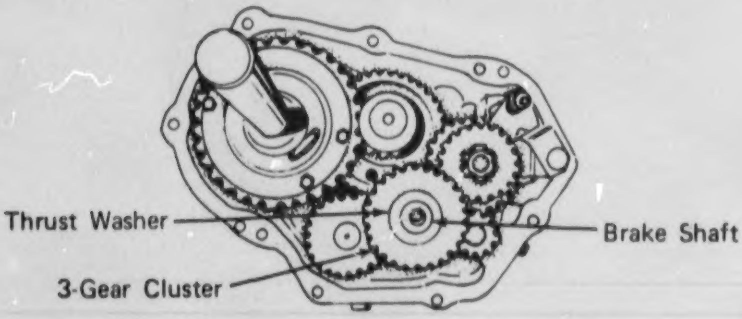

Squeeze Shifter Rods to Hold Shifter Assembly Together
Shifter Rod Socket

F. Install shifter assembly as a unit into the cover (Figure 4)

(NOTE: Squeeze shifter rods to hold shifter assembly together.)

G. Install the three gear cluster and thrust washer (Figure 5)

FIGURE 5

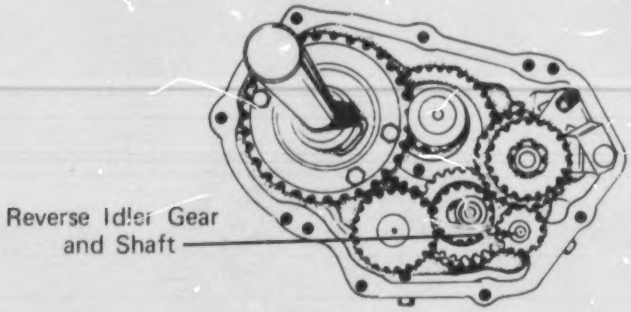

Thrust Washer
Brake Shaft
3-Gear Cluster

JOB SHEET #2

H. Install the reverse idler shaft, spacer, and gear into the cover (Figure 6)

(NOTE: The beveled side of the idler gear should be down into the cover.)

FIGURE 6


Reverse Idler Gear
and Shaft

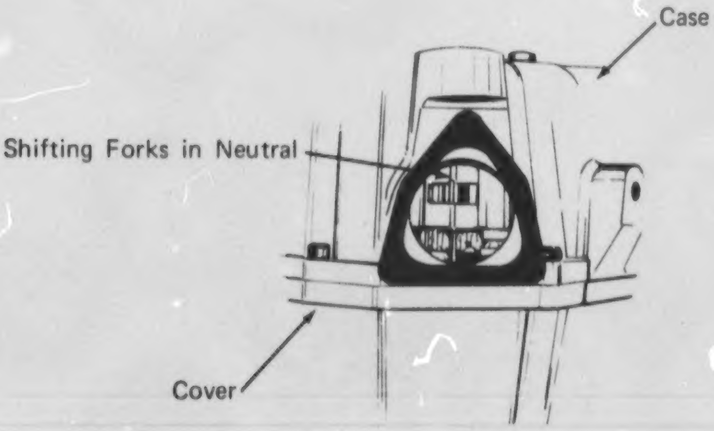
I. Install the gasket on the cover

J. Install case over the differential shaft

(NOTE: Be sure the boss goes under gear and that the edge of the case goes over the shaft rods.)

K. Align shifting fork to neutral position (Figure 7)

FIGURE 7


Case
Shifting Forks in Neutral
Cover

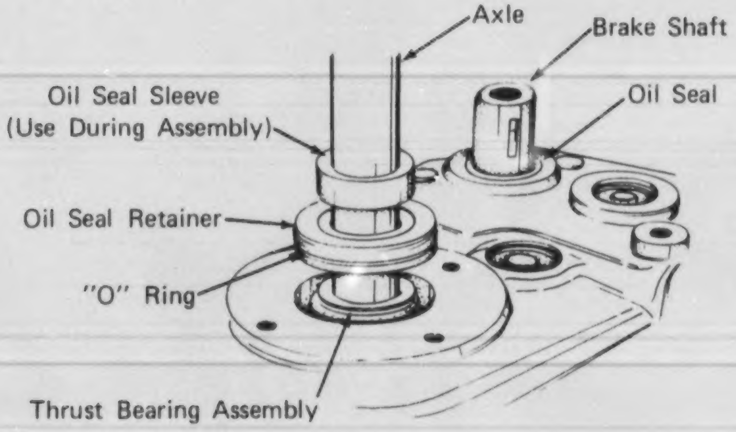
JOB SHEET #2

L. Align the case and cover with the two dowel pins, then install and tighten the capscrews

(NOTE: Check service manual for proper torque.)

M. Install seal retainers and seals (Figure 8)

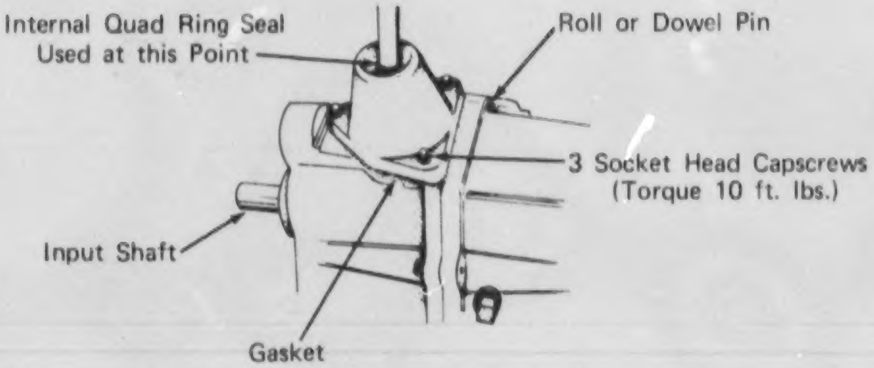
FIGURE 8


Axle
Brake Shaft
Oil Seal Sleeve
(Use During Assembly)
Oil Seal
Oil Seal Retainer
"O" Ring
Thrust Bearing Assembly

N. Install axle housing to case and cover

O. Install shift lever housing gasket and capscrews (Figure 9)

FIGURE 9


Internal Quad Ring Seal
Used at this Point
Roll or Dowel Pin
3 Socket Head Capscrews
(Torque 10 ft. lbs.)
Input Shaft
Gasket

JOB SHEET #2

P. With the shift fork in neutral, rotate both axle ends in the same direction. They should turn smoothly although a little effort may be necessary

(NOTE: The brake shaft should rotate whenever the axles turn together, but in neutral, the input shaft should not turn.)

Q. Shift any gear into mesh and rotate axle

(NOTE: A greater drag should be felt on the axles and both the input and brake shaft should turn.)

LG - 73-E

FOUR-SPEED TRANSAXLE
UNIT III

NAME ______________________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. A combination of familiar parts of a drive train; the transmission, differential, and axles, in one compact unit

_____b. A gear having the shaft bore and teeth in a parallel plane

_____c. A raised part or protruding part on a flat surface

_____d. A mechanism at the rear axles that permits one rear wheel to turn at a different speed than the other

_____e. Slots or grooves cut in a shaft or bore

_____f. An extension of the case and cover to support the outer ends of the axles

_____g. That shaft on a transaxle to which a braking system may be attached

_____h. Diagonal milling at the corners of gear teeth to remove sharp edges

_____i. Mechanical devices used to transmit power, or turning effort from one shaft to another

1. Differential
2. Splines
3. Gears
4. Boss
5. Transaxle
6. Brakeshaft
7. Chamfer
8. Spur gear
9. Axle housing

2. Identify the parts of the four-speed transaxle.

a. ____________________ h. ____________________

b. ____________________ i. ____________________

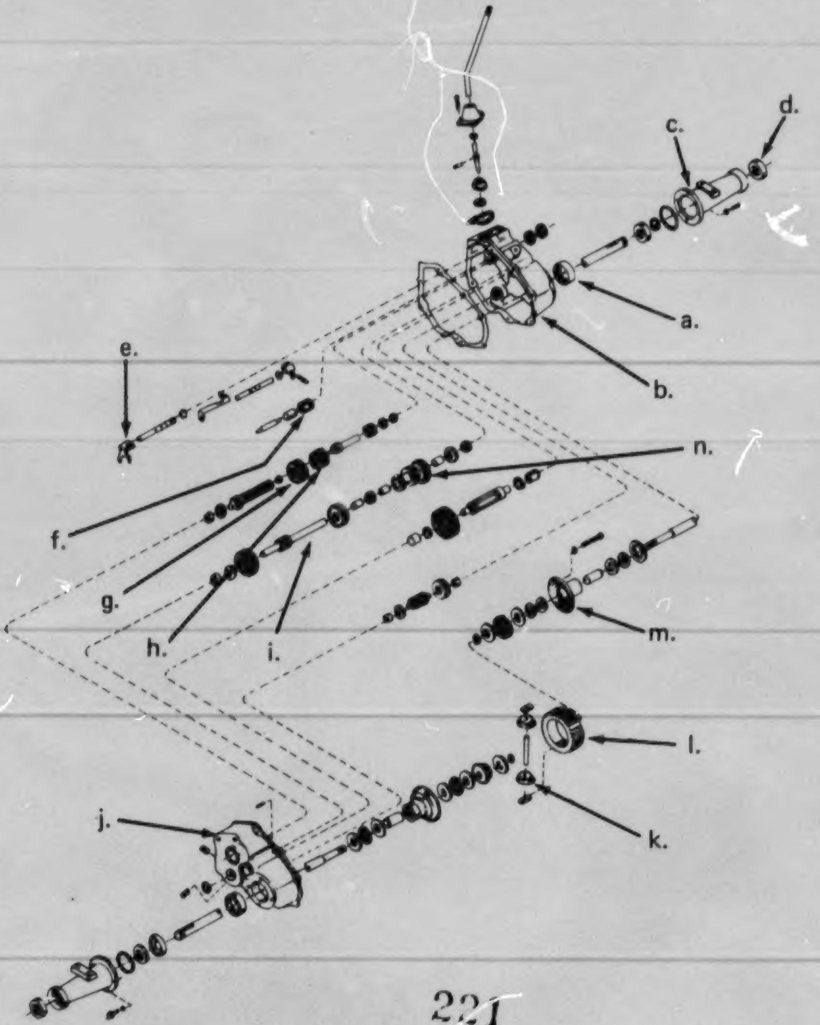
c. ____________________ j. ____________________

d. ____________________ k. ____________________

e. ____________________ l. ____________________

f. ____________________ m. ____________________

g. ____________________ n. ____________________


c.
d.
a.
b.
e.
n.
f.
g.
h.
i.
m.
l.
j.
k.

3. List four common problems with four-speed transaxles.

   a.

   b.

   c.

   d.

4. Demonstrate the ability to:

   a. Disassemble and inspect a four-speed transaxle.

   b. Reassemble and test a four-speed transaxle.

FOUR-SPEED TRANSAXLES
UNIT III

ANSWERS TO TEST

1. a. 5
   b. 8
   c. 4
   d. 1
   e. 2
   f. 9
   g. 6
   h. 7
   i. 3
2. a. Carrier bearing
   b. Transaxle case
   c. Axle housing
   d. Axle outer bearing
   e. Shift fork
   f. Reverse Idler gear
   g. 1st, 2nd, and reverse gear
   h. 3rd and 4th gear
   i. Brake and cluster shaft
   j. Transaxle cover
   k. Bevel pinion gear
   l. Ring gear
   m. Differential carrier
   n. 3-cluster gear
3. a. Unit cannot be shifted
   b. Unit is noisy
   c. Axles cannot be turned (same direction) with unit in neutral
   d. Unit does not drive
4. Performance skills evaluated to the satisfaction of the instructor

IN LINE FIVE-SPEED TRANSMISSION
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to disassemble inspect, and reassemble a five-speed transmission. The student should also be able to identify the parts and match terms to definitions of the five-speed transmission. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with the in line five-speed transmission to the correct definitions.
2. Identify parts of the five-speed transmission.
3. Demonstrate the ability to:
   a. Disassemble and inspect a five-speed transmission.
   b. Reassemble a five-speed transmission.

IN LINE FIVE-SPEED TRANSMISSION
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.
   B. Provide student with information and job sheets.
   C. Make transparency.
   D. Discuss unit and specific objectives.
   E. Discuss information sheet.
   F. Demonstrate and discuss the procedures outlined in the job sheets.
   G. Give test.

II. Student:

   A. Read objective sheet.
   B. Study information sheet.
   C. Complete job sheets.
   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet
   B. Information sheet
   C. Transparency master: TM 1--Parts of the Five-Speed Transmission
   D. Job sheets
      1. Job Sheet #1--Disassemble and Inspect a Five-Speed Transmission
      2. Job Sheet #2--Reassemble a Five-Speed Transmission
   E. Test
   F. Answers to test

References:

A. *Small Tractor Service Manual.* Vol. 2. Kansas City, Missouri: Technical Publications Division/Intertec Publishing Co., 1975.

B. *Peerless Mechanic's Manual.* Grafton, Wisconsin: Engine Division/ Peerless

IN LINE FIVE-SPEED TRANSMISSION
UNIT IV

INFORMATION SHEET

I. Terms and definitions

   A. Shifting fan--A locking device which fits into a detent, slot, or groove during certain times to hold a part stationary

   B. Key way--A groove or slot cut to permit insertion of a key

   (NOTE: This is sometimes called a key seat.)

   C. Pinion gear--The smaller of two meshed bevel gears in a gear train

   D. Countershaft--The shaft in the transmission which is driven by the input shaft

   E. Brake disc--A circular plate against which brake lining is forced to retard motion of the unit

   F. Neutral start switch--A safety switch which only allows the engine supply to start only in the neutral position

   G. Collar--A ring or round flange used to limit motion along a shaft

   H. Needle bearing--An antifriction bearing using a great number of rollers of small diameter in relation to their length

II. Parts of the five speed transmission (Transparency 1)

   A. Flange bushing

   B. Set screw

   C. Detent spring

   D. Detent ball

   E. Speed gears

   F. Shifter keys

   G. Output shaft

   H. Shift collar

   I. Reverse sprocket

   J. Reverse chain

   K. Shift rod and fork assembly

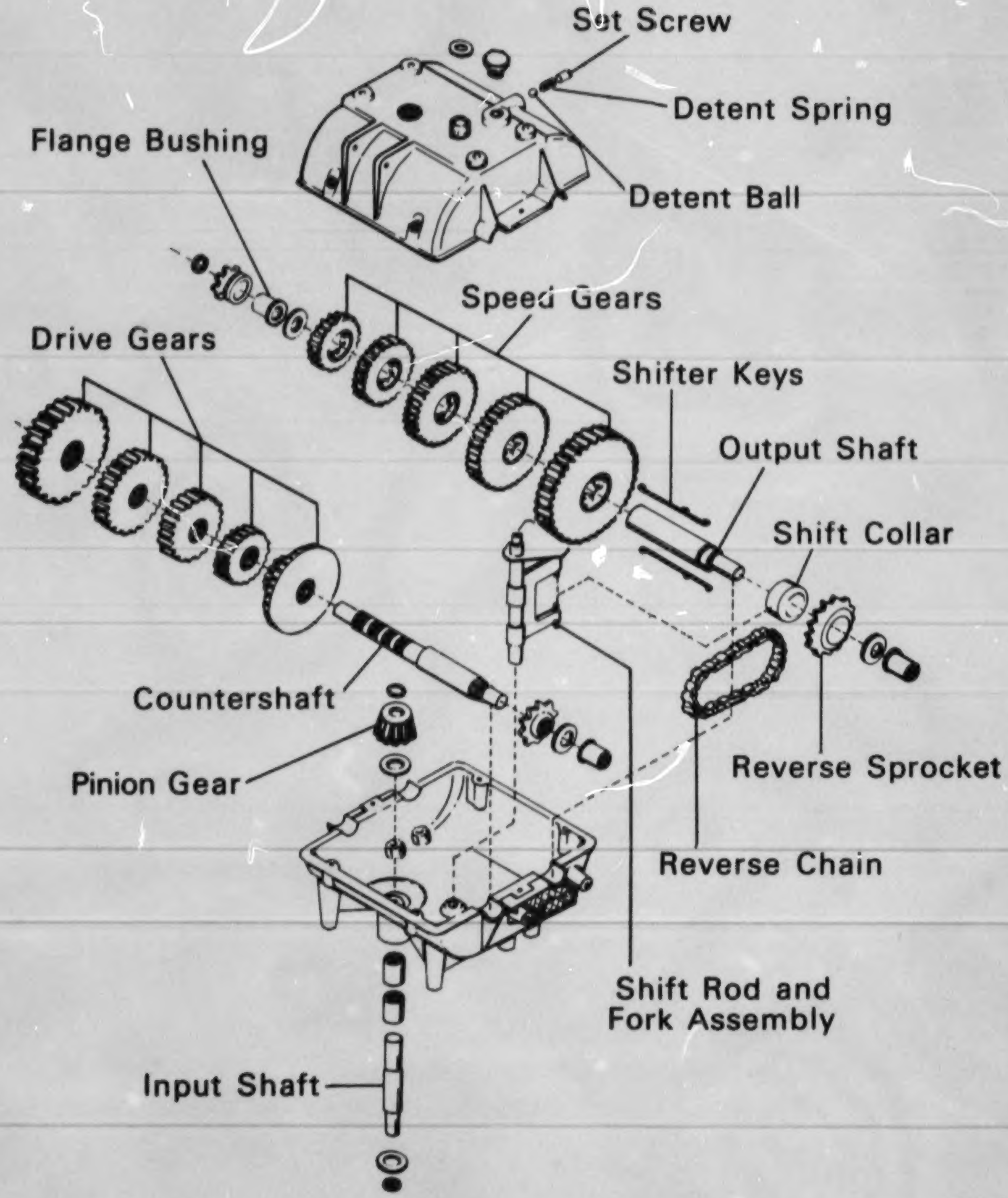
INFORMATION SHEET

L. Input shaft

M. Pinion gear

N. Countershafts

Parts of the Five-Speed Transmission


Set Screw
Detent Spring
Flange Bushing
Detent Ball
Speed Gears
Drive Gears
Shifter Keys
Output Shaft
Shift Collar
Countershaft
Pinion Gear
Reverse Sprocket
Reverse Chain
Shift Rod and Fork Assembly
Input Shaft

IN LINE FIVE-SPEED TRANSMISSION
UNIT IV

JOB SHEET #1--DISASSEMBLE AND INSPECT A FIVE-SPEED TRANSMISSION

I. Tools and materials

   A. Safety glasses

   B. Hand tools

   C. Snap ring pliers

   D. Cleaning solvent

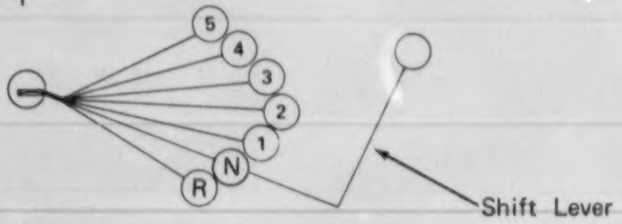
   E. Service manual

II. Procedure

   A. Disassemble a five-speed transmission

      1. Position shift lever in neutral position (Figure 1)

FIGURE 1

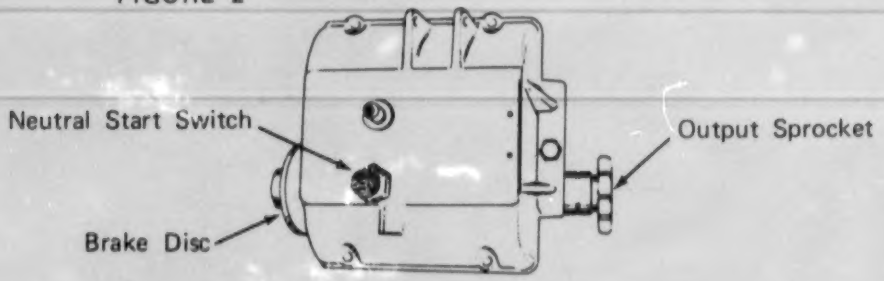

5
4
3
2
1
N
R
Shift Lever

      2. Remove shift lever

      3. Remove neutral start switch (Figure 2)

      (NOTE: A neutral start switch may not be installed on all models.)

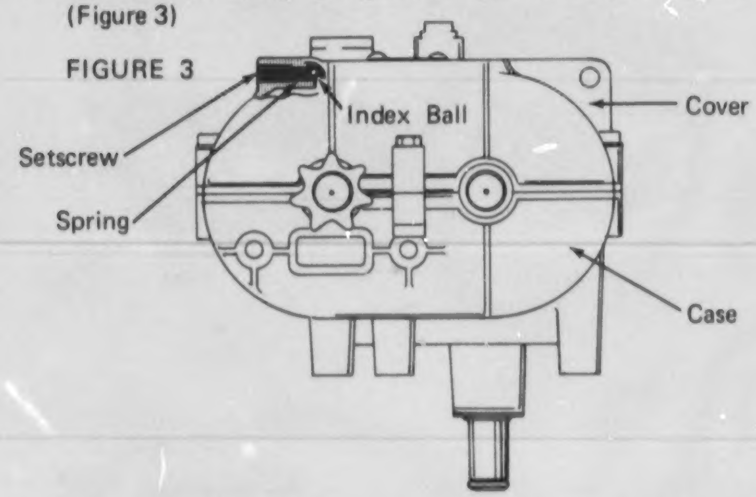
FIGURE 2


Neutral Start Switch
Output Sprocket
Brake Disc

JOB SHEET #1

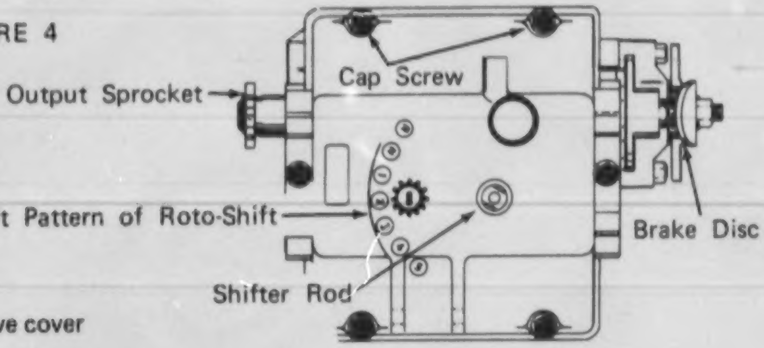
4. Remove set screw, spring and index ball from transmission cover (Figure 3)

FIGURE 3


Index Ball
Cover
Setscrew
Spring
Case

5. Remove cap screws that maintain cover to case (Figure 4)

FIGURE 4

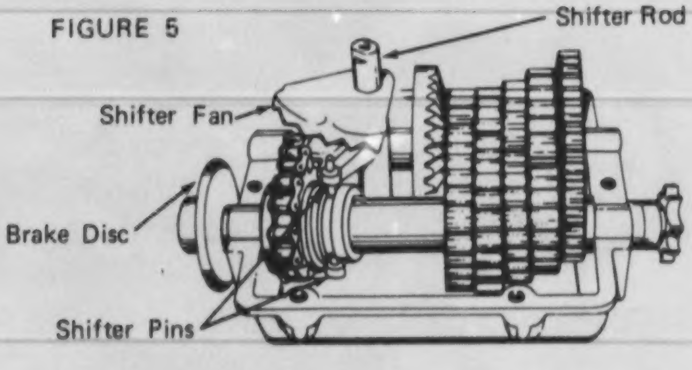

Cap Screw
Output Sprocket
Shift Pattern of Roto-Shift
Brake Disc
Shifter Rod

6. Remove cover

7. Remove shifter assembly (Figure 5)

(NOTE: This includes shaft, pins and fan.)

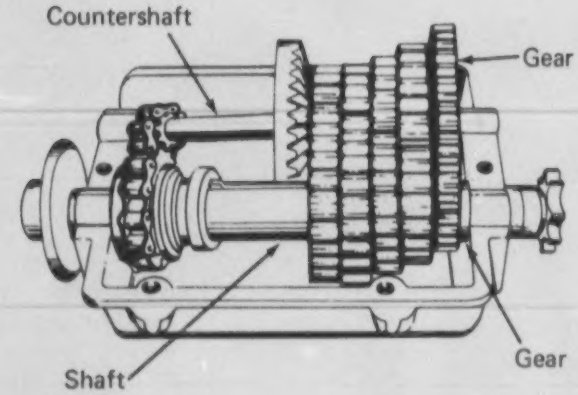
FIGURE 5


Shifter Rod
Shifter Fan
Brake Disc
Shifter Pins

JOB SHEET #1

8. Remove gear and shaft assemblies from case half of the transmission (Figure 6)

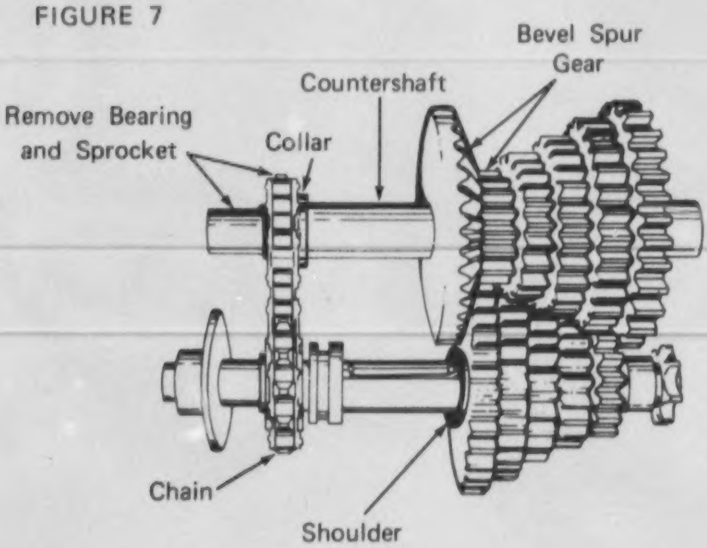
FIGURE 6


Countershaft
Gear
Gear
Shaft

9. Angle chain and sprocket ends of shaft toward each other, removing the bearing and sprocket from countershaft (Figure 7)

(NOTE: The collar on the sprocket faces the bevel spur gear.)

FIGURE 7

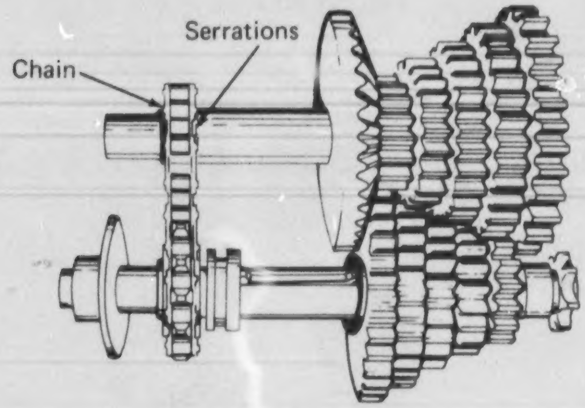

Bevel Spur Gear
Countershaft
Remove Bearing and Sprocket
Collar
Chain
Shoulder

JOB SHEET #1

10. Remove chain (Figure 8)

    (NOTE: Some chain link pins may have to be cut for removal or reassembly.)

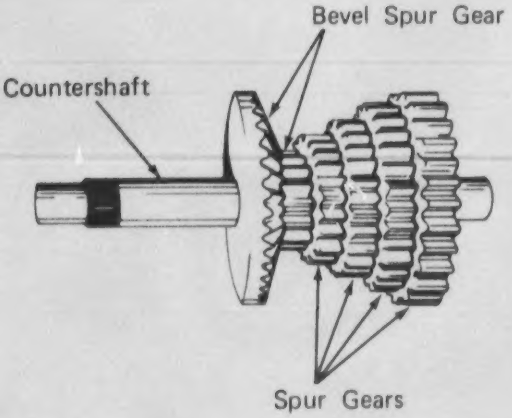
    FIGURE 8


Serrations
Chain

11. Remove bevel spur gear combination and spur gears from the countershaft (Figure 9)

    (NOTE: These gears are splined to the countershaft.)

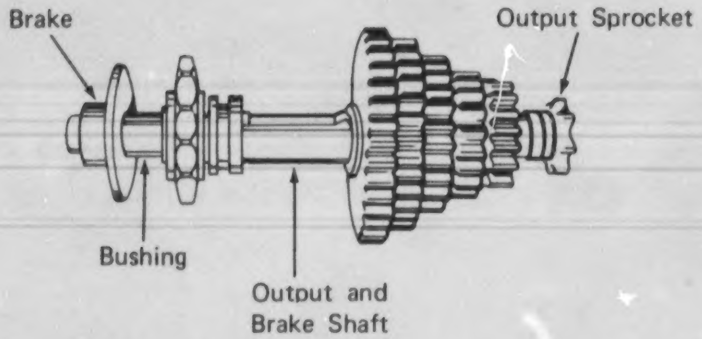
    FIGURE 9


Bevel Spur Gear
Countershaft
Spur Gears

JOB SHEET #1

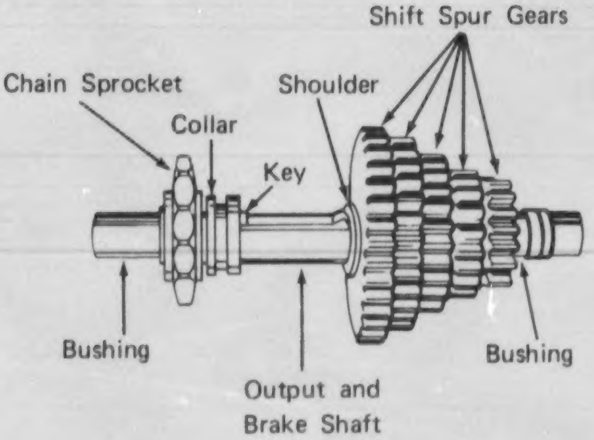
12. Remove the output sprocket and brake disc from the output shaft (Figure 10)

FIGURE 10


Brake
Output Sprocket
Bushing
Output and
Brake Shaft

13. Remove the bushings, shift spur gears, chain sprocket, collar and keys (Figure 11)

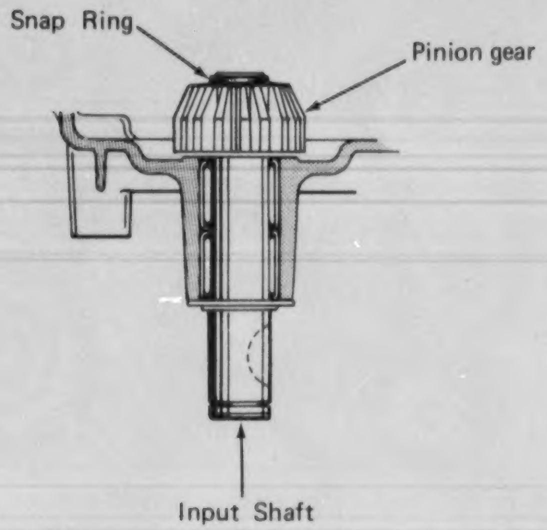
FIGURE 11


Shift Spur Gears
Chain Sprocket
Shoulder
Collar
Key
Bushing
Bushing
Output and
Brake Shaft

JOB SHEET #1

14. Remove snap ring from input shaft (Figure 12)

FIGURE 12



15. Remove pinion gear and pull shaft through case (Figure 12)

16. Remove input shaft needle bearing, if necessary

B. Inspect a five-speed transmission

1. Check all gear bevels for galling and check face of teeth for wear due to improper shifting

   (NOTE: Large shiny areas indicate too much tooth contact and possible excessive wear.)

2. Check all bearing surfaces and bearings

3. Check shaft surfaces for rust, pitting, scratches or wear; also check keyway, splines, thread, and grooves for wear

4. Check case and cover for cracks, stripped threads, metal chips, flat sealing surfaces and rust

5. Check all thrust washers and spacers for wear

IN LINE FIVE-SPEED TRANSMISSION
UNIT IV

JOB SHEET #2--REASSEMBLE A FIVE-SPEED TRANSMISSION

I. Tools and materials

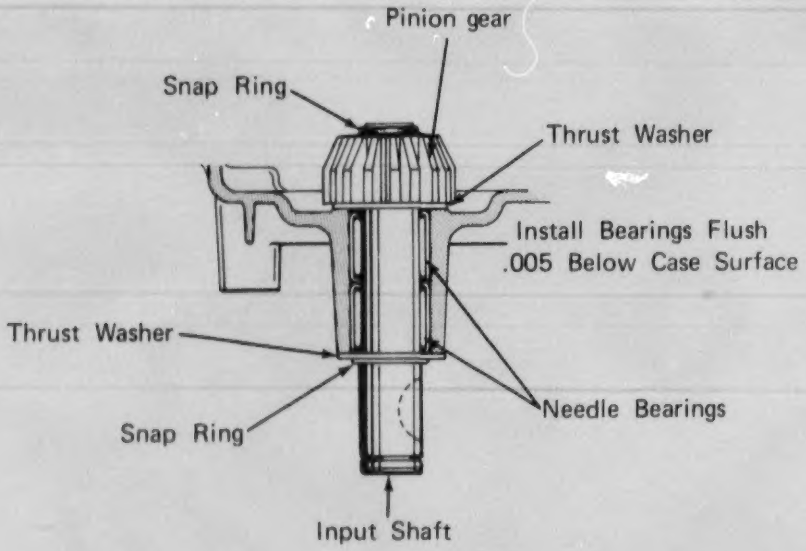
- A. Safety glasses
- B. Hand tool assortment
- C. Snap ring pliers
- D. Appropriate service manual
- E. Manufacturer's recommended lubricant

II. Procedure

A. Reassemble a five-speed transmission

1. Install pinion gear on input shaft (Figure 1)

FIGURE 1


Pinion gear
Snap Ring
Thrust Washer
Install Bearings Flush
.005 Below Case Surface
Thrust Washer
Needle Bearings
Snap Ring
Input Shaft

2. Install and secure the input shaft and pinion gear in the case (Figure 1)

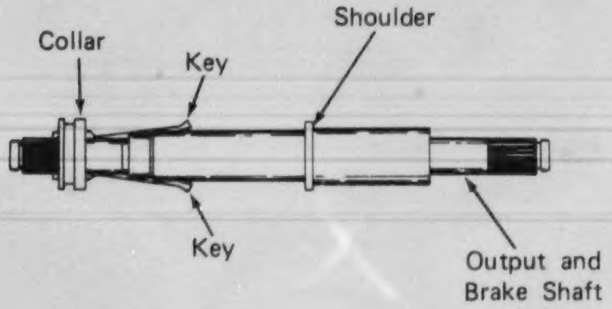
(NOTE: If bearings are used, be sure bearings are installed flush to .005 below case surface.)

JOB SHEET #2

3. Install collar and shifter keys to output and brake shaft (Figure 2)

(NOTE: Thick side of collar must face shoulder on shaft

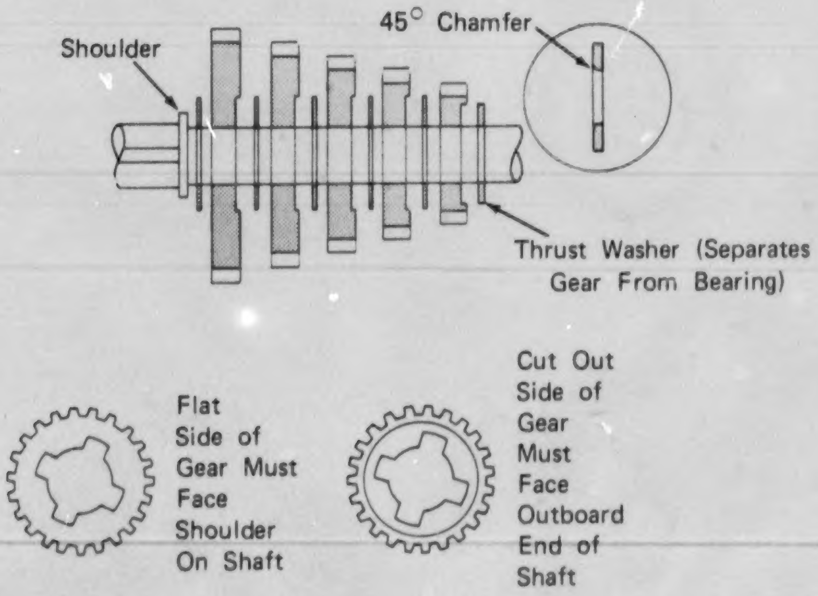
FIGURE 2


Shoulder
Collar
Key
Key
Output and Brake Shaft

4. Install shift spur gears starting with largest to the smallest (Figure 3)

(NOTE: Some models may have fewer thrust washers than illustrated in Figure 3.)

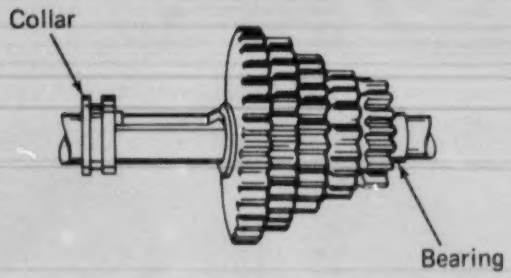
FIGURE 3


45° Chamfer
Shoulder
Thrust Washer (Separates Gear From Bearing)
Flat Side of Gear Must Face Shoulder On Shaft
Cut Out Side of Gear Must Face Outboard End of Shaft

JOB SHEET #2

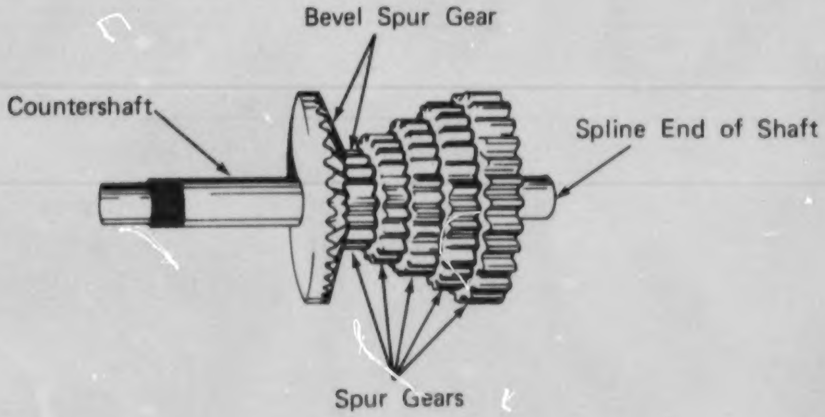
5. When correctly assembled the output shaft should appear as shown (Figure 4)

FIGURE 4


Collar
Bearing

6. Install bevel spur gear and smallest to largest spur gears to the splined end of the countershaft (Figure 5)

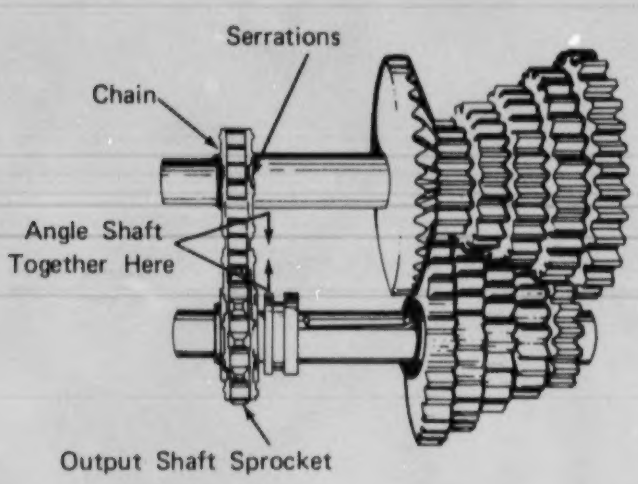
FIGURE 5


Bevel Spur Gear
Countershaft
Spline End of Shaft
Spur Gears

JOB SHEET #2

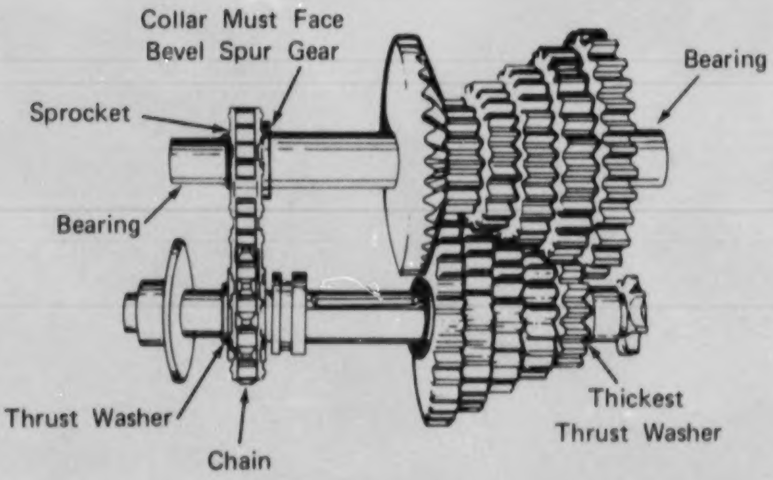
7. Install chain over two shaft registering chain on output shaft sprocket and in-line with serration on countershaft (Figure 6)

FIGURE 6


Serrations
Chain
Angle Shaft Together Here
Output Shaft Sprocket

8. Install sprocket onto serration and install chain (Figure 7)

FIGURE 7


Collar Must Face Bevel Spur Gear
Bearing
Sprocket
Bearing
Thrust Washer
Chain
Thickest Thrust Washer

9. Install thrust washer (Figure 7)

(NOTE: Washers may be of varying thickness, assemble in proper location.)

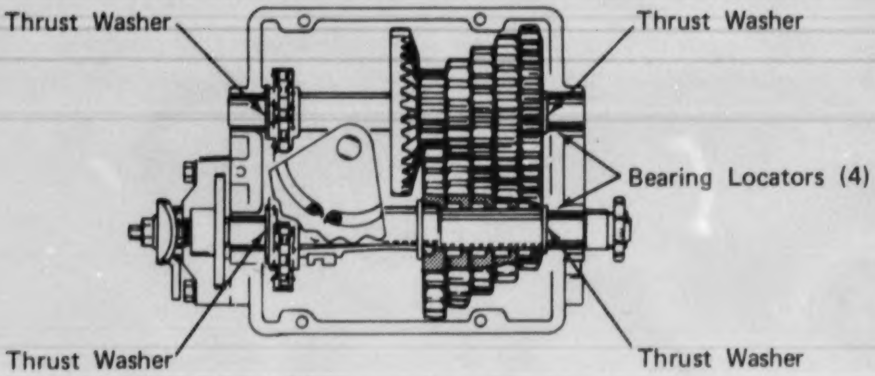
JOB SHEET #2

10. Install shaft assemblies into case (Figure 8)

    (NOTE: Utilize the piloting locators on the bearing to properly align notches in case.)

    (CAUTION: Be sure bearing locators are seated in transmission case.)

    FIGURE 8


Thrust Washer
Thrust Washer
Bearing Locators (4)
Thrust Washer
Thrust Washer

11. Install shifter assembly (Figure 8)
12. Apply manufacturer's recommended lubricant
13. Install cover on case and cap screws

    (NOTE: Check service manual for proper torque.)

IN LINE FIVE-SPEED TRANSMISSION
UNIT IV

NAME ____________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. The shaft in the transmission which is driven by the input shaft

_____b. The smaller of the two meshed bevel gears in a gear train

_____c. A groove or slot cut to permit insertion of a key

_____d. A locking device which fits into a detent, slot, or groove during certain times to hold a part stationary

_____e. An antifriction bearing using a great number of rollers of small diameter in relation to their length

_____f. A ring or round flange used to limit motion along a shaft

_____g. A safety switch which only allows the engine supply to start only in the neutral position

_____h. A circular plate against which brake lining is forced to retard motion of the unit

1. Key way
2. Needle bearing
3. Shifting fan
4. Pinion gear
5. Countershaft
6. Neutral start switch
7. Brake disc
8. Collar

2. Identify the major parts of the five-speed transmission.

a.

b.

c.

d.

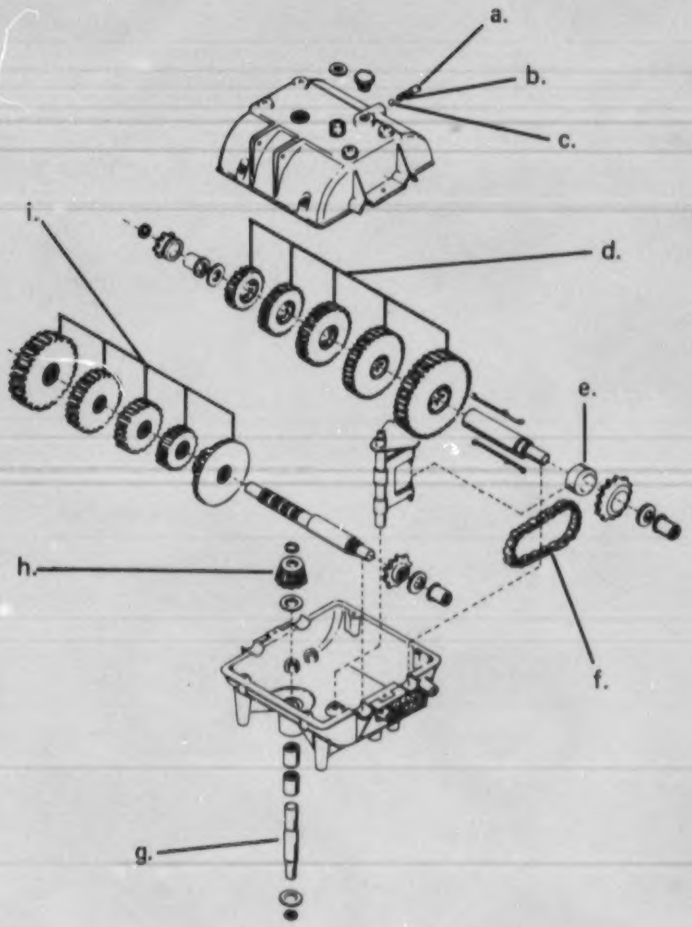
e.

f.

g.

h.

i.



3. Demonstrate the ability to:

a. Disassemble and inspect a five-speed transmission

b. Reassemble a five-speed transmission.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

IN LINE FIVE-SPEED TRANSMISSION
UNIT IV

ANSWERS TO TEST

1. a. 5
   b. 4
   c. 1
   d. 3
   e. 2
   f. 8
   g. 6
   h. 7
2. a. Set screw
   b. Detent spring
   c. Detent ball
   d. Speed gears
   e. Shift collar
   f. Reverse chain
   g. Input shaft
   h. Pinion gear
   i. Drive gears
3. Performance skills evaluated to the satisfaction of the instructor

HYDROSTATIC DRIVES
UNIT V

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify types of hydrostatic drives as well as components. The student should also be able to disassemble, inspect, repair and reassemble an axial piston hydrostatic drive. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with hydrostatic drives to the correct definitions.
2. Identify common hydrostatic drive system components.
3. Identify common types of hydrostatic drive systems.
4. List four common causes for system malfunctions.
5. Describe fluid flow through a hydrostatic system when given a hydrostatic oil flow diagram
6. Demonstrate the ability to disassemble, inspect, repair, and reassemble an axial piston hydrostatic drive.

HYDROSTATIC DRIVES
UNIT V

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information and job sheets.

   F. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheet.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Hydrostatic Drive System Components

      2. TM 2--Types of Hydrostatic Drive Systems

      3. TM 3--Types of Hydrostatic Drive Systems (Continued)

      4. TM 4--Fluid Flow Diagram

   D. Job Sheet #1--Disassemble, Inspect, Repair, and Reassemble an Axial Piston Hydrostatic Drive

E. Test

F. Answers to test

II. References:

A. *Hydraulics: Hydraulic Systems for Tractors and Other Mobile Equipment, Inspecting and Testing, Volume 2.* Athens, Georgia: AAVIM, 1974.

B. *Compact Service Manual, Vol. 2.* 1st [illegible]dition, Kansas City, Mo: Technical Publications Division/Intertec Publishing Corporation, 1975.

HYDROSTATIC DRIVES
UNIT V

INFORMATION SHEET

I. Terms and definitions

   A. Hydrostatic drive--Power transfer system that uses the rotating power from the engine to drive a pump which supplies hydraulic fluid under pressure to a hydraulic motor which powers the drive wheels through a differential and/or transmission

   B. Axial piston--Piston arrangement in pumps and motors where piston bores are situated in straight lines along the cylinder's axis

   C. Radial piston--Piston arrangement in pumps and motors where the piston bores are at a 90° angle to the cylinder axis

   D. Charge pump--Smaller low pressure pump used to supply fluid to main system pump

   E. Acceleration valves--Control and relief valves used in high and low pressure circuits (before and after motor) to protect system from damage due to surges caused by sudden movement of the control lever

II. Hydrostatic drive system components (Transparency 1)

   A. Charge pump

   B. Pump

   C. Motor

   D. Filter

   E. Reservoir

   F. Control valve

   G. Valves

   (NOTE: Many types of valves are used in hydrostatic drive systems.)

III. Types of hydrostatic drive systems (Transparencies 2 and 3)

   A. Axial piston to axial piston

   B. Axial piston to gear

   C. Radial piston to radial piston

INFORMATION SHEET

IV. Causes of system malfunctions

- A. Loose lines
- B. Contaminants in the system
- C. Excessive component wear
- D. Low fluid level

V. Hydrostatic fluid flow diagram

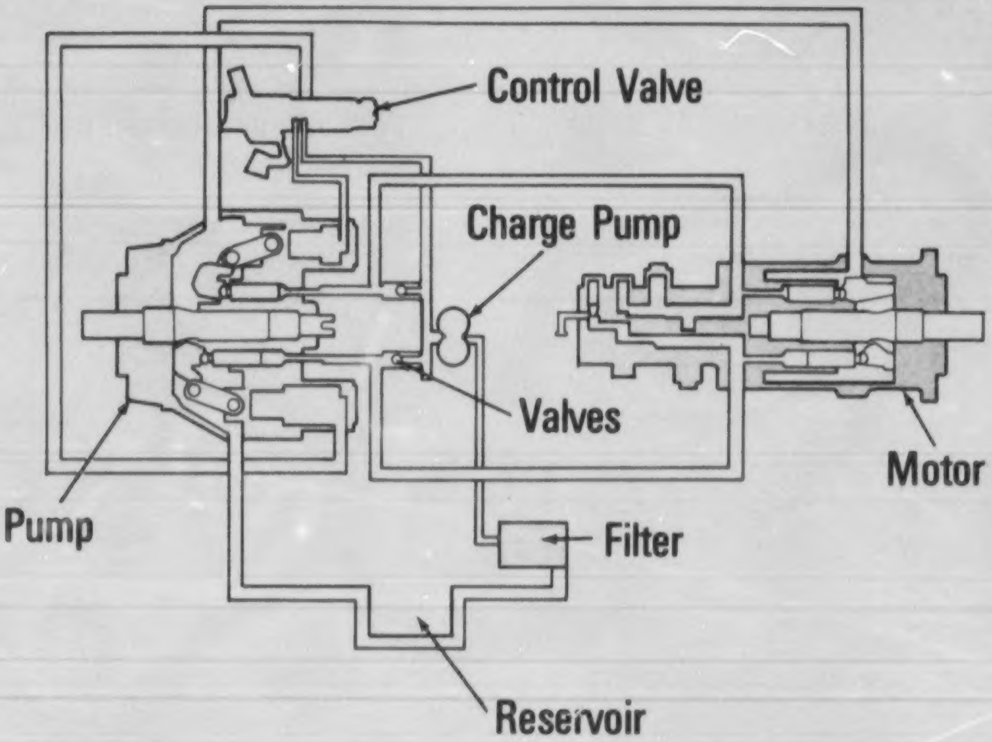
- A. Rotor type charge pump pulls under suction
- B. Charge pump pressures fluid through check valve on pump inlet side

  (NOTE: Swash plate tilt determines inlet and outlet.)
- C. Pump increases pressure and fluid flow volume

  (NOTE: Tilt of swash plate determines volume. Volume determines hydraulic motor speed.)
- D. Fluid enters motor under high pressure
- E. Fluid pressure rotates shaft and low pressure fluid returns to reservoir and pump

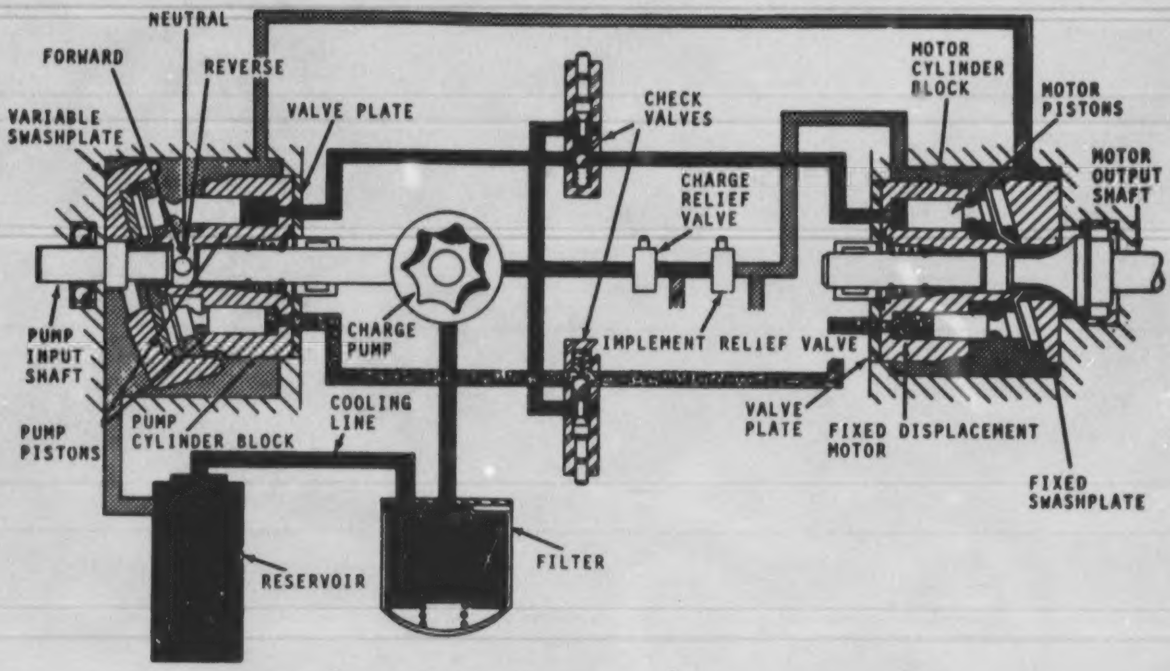
  (NOTE: Some of the fluid is circulated to cool the pump and the motor.)

Hydrostatic Drive System Components

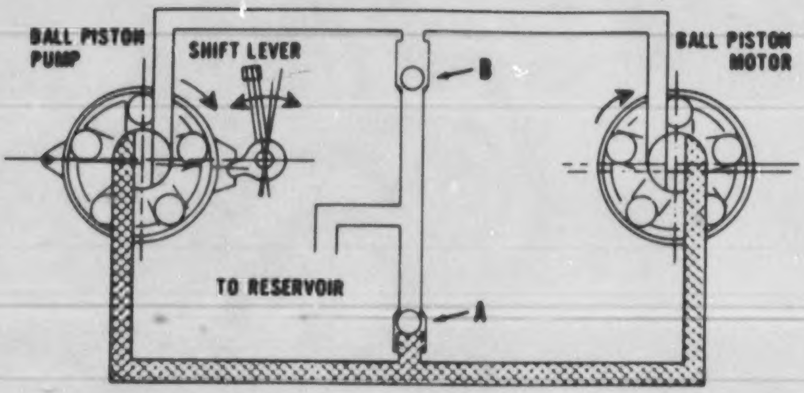

Control Valve
Charge Pump
Valves
Motor
Pump
Filter
Reservoir

Types of Hydrostatic Drive Systems

Axial Piston to Axial Piston


NEUTRAL
FORWARD
REVERSE
VARIABLE SWASHPLATE
VALVE PLATE
CHECK VALVES
MOTOR CYLINDER BLOCK
MOTOR PISTONS
MOTOR OUTPUT SHAFT
CHARGE RELIEF VALVE
CHARGE PUMP
IMPLEMENT RELIEF VALVE
PUMP INPUT SHAFT
COOLING LINE
VALVE PLATE
FIXED DISPLACEMENT MOTOR
PUMP PISTONS
PUMP CYLINDER BLOCK
FIXED SWASHPLATE
RESERVOIR
FILTER

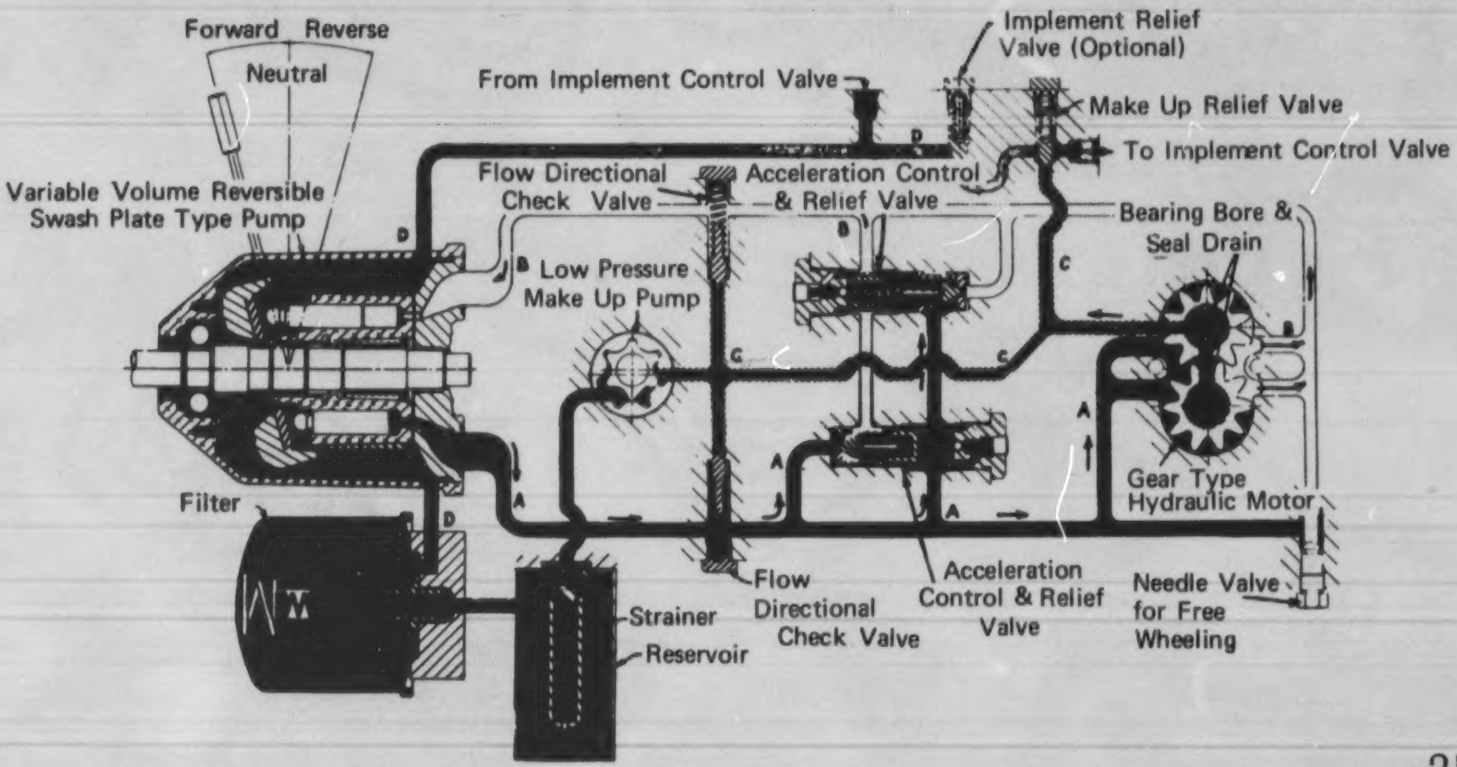
Radial Piston to Radial Piston


BALL PISTON PUMP
SHIFT LEVER
B
BALL PISTON MOTOR
TO RESERVOIR
A

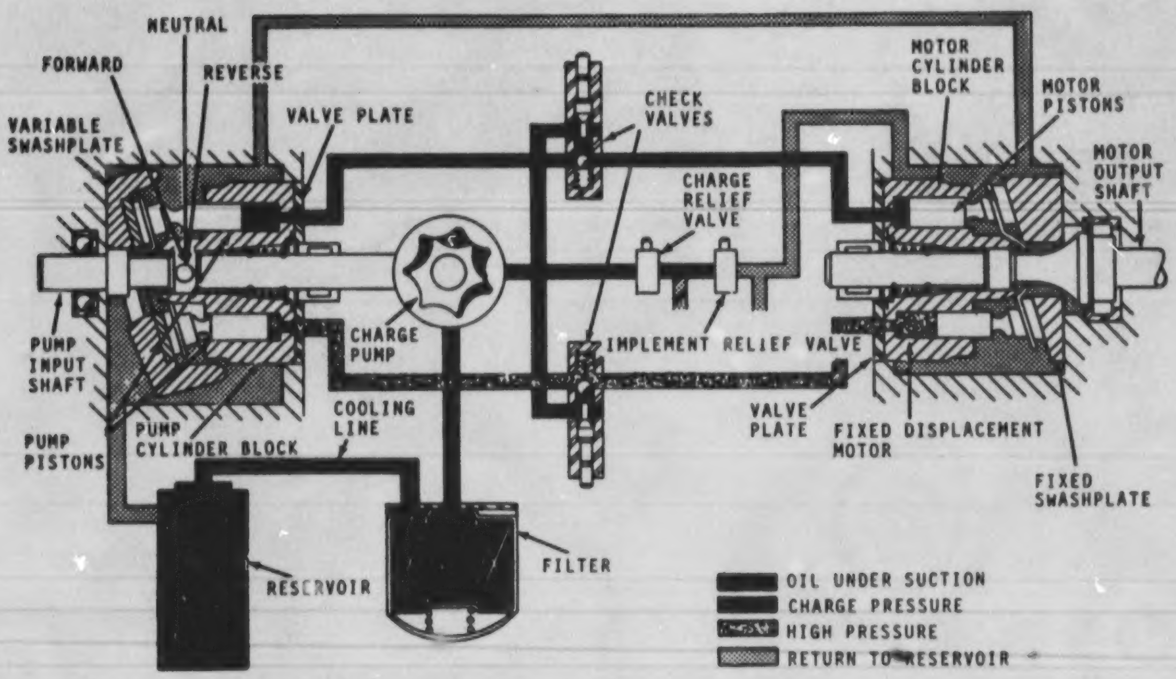
Types of Hydrostatic Drive Systems

(Continued)

Axial Piston to Gear


Forward
Reverse
Neutral
Variable Volume Reversible Swash Plate Type Pump
Filter
From Implement Control Valve
Implement Relief Valve (Optional)
Make Up Relief Valve
To Implement Control Valve
Flow Directional Check Valve
Acceleration Control & Relief Valve
Bearing Bore & Seal Drain
Low Pressure Make Up Pump
Gear Type Hydraulic Motor
Strainer
Reservoir
Flow Directional Check Valve
Acceleration Control & Relief Valve
Needle Valve for Free Wheeling
A
B
C
D

Fluid Flow Diagram


NEUTRAL
FORWARD
REVERSE
VARIABLE SWASHPLATE
VALVE PLATE
CHECK VALVES
CHARGE RELIEF VALVE
MOTOR CYLINDER BLOCK
MOTOR PISTONS
MOTOR OUTPUT SHAFT
PUMP INPUT SHAFT
CHARGE PUMP
IMPLEMENT RELIEF VALVE
PUMP PISTONS
PUMP CYLINDER BLOCK
COOLING LINE
VALVE PLATE
FIXED DISPLACEMENT MOTOR
FIXED SWASHPLATE
RESERVOIR
FILTER
OIL UNDER SUCTION
CHARGE PRESSURE
HIGH PRESSURE
RETURN TO RESERVOIR

HYDROSTATIC DRIVES
UNIT V

JOB SHEET #1--DISASSEMBLE, INSPECT, REPAIR, AND REASSEMBLE AN AXIAL PISTON HYDROSTATIC DRIVE

I. Tools and materials

   A. Hand tool assortment

   B. Parts brush

   C. Solvent

   D. Press

   E. Step plate

   F. Appropriate service manual

   G. Lint free towels

   H. Micrometer

   I. New gasket set

   J. Safety glasses

II. Procedure

(NOTE: Be sure and make all possible running checks to determine that the hydrostatic drive unit is defective before disassembling.)

   A. Gather tools and materials

   B. Put on safety glasses

   C. Disconnect plug wire and ground it to engine block

   D. Remove hydrostatic drive unit

   (NOTE: Mark the location of lines and all fasteners for reinstallation of drive unit. Plug all open lines and place all removed tractor components in an orderly fashion for reassembly. Consult appropriate service manual if possible.)

   E. Clean all outside surfaces on transmission

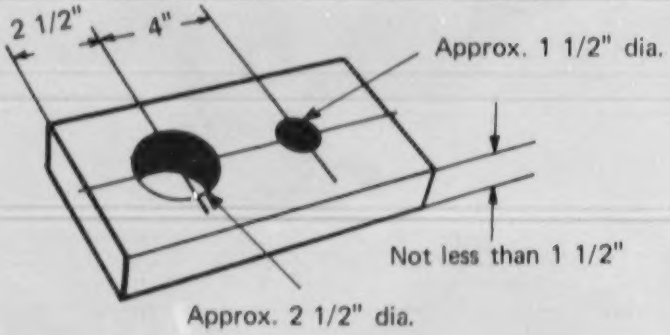
   (NOTE: Be sure the unit is completely cleaned and is free of any dirt that could enter the unit on disassembly.)

JOB SHEET #1

F. Set the drive unit in a convenient place for disassembly

(NOTE: It may be possible to construct a holding block. See Figure 1.)

FIGURE 1



G. Remove charge pump

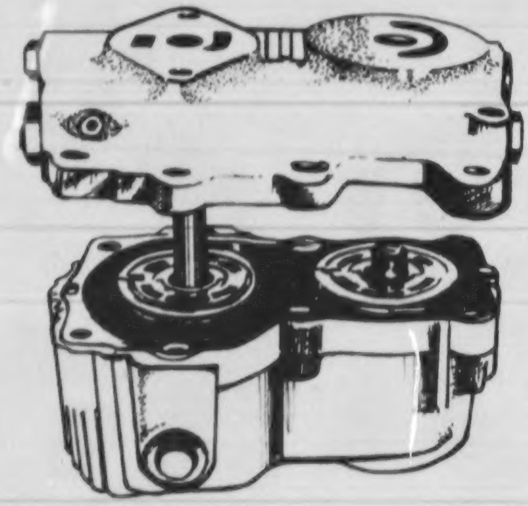
(NOTE: Be sure and scribe the charge pump housing and drive unit housing before removing the unit for ease in reinstallation.)

H. Remove screws connecting pump and motor face plate or housing

I. Remove pump and motor housing (Figure 2)

(CAUTION: The valve plates may stick to the housing; be careful not to drop them.)

FIGURE 2

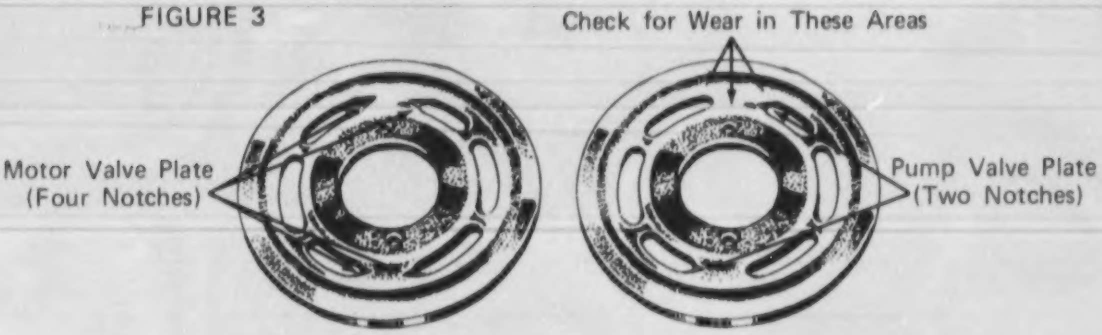


JOB SHEET #1

J. Remove pump and motor valve plates (Figure 3)

1. Check valve plates for wear
2. Remove valve plate pins

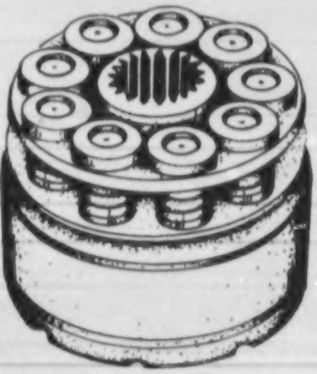
FIGURE 3


Check for Wear in These Areas
Motor Valve Plate (Four Notches)
Pump Valve Plate (Two Notches)

K. Tilt transmission assembly

L. Remove pump and motor block assemblies (Figure 4)

FIGURE 4

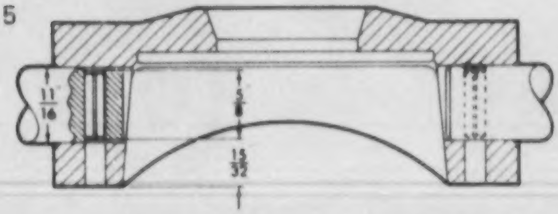


M. Remove pump swash plate

1. Mark a pin punch exactly 15/32" from the end
2. Drive or push spring pins till mark is even with surface of swash plate (Figure 5)

(CAUTION: Do not go farther than your punch mark.)

FIGURE 5


11/16
5/8
15/32

JOB SHEET #1

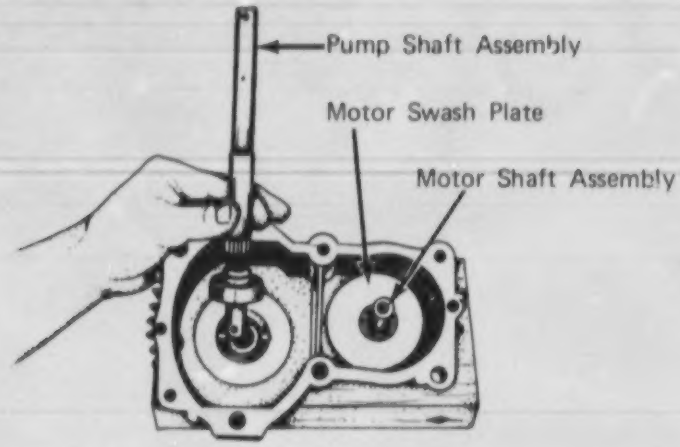
3. Pull shaft from swash plate

4. Repeat for other shaft

5. Remove swash plate from case

N. Remove pump shaft assembly (Figure 6)

FIGURE 6

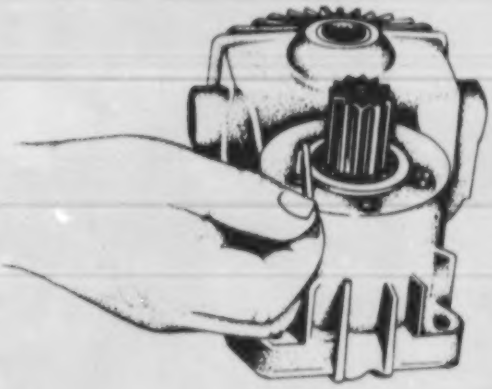

Pump Shaft Assembly
Motor Swash Plate
Motor Shaft Assembly

O. Remove motor swash plate

1. Turn housing over

2. Remove swash plate screws (Figure 7)

FIGURE 7



3. Remove swash plate

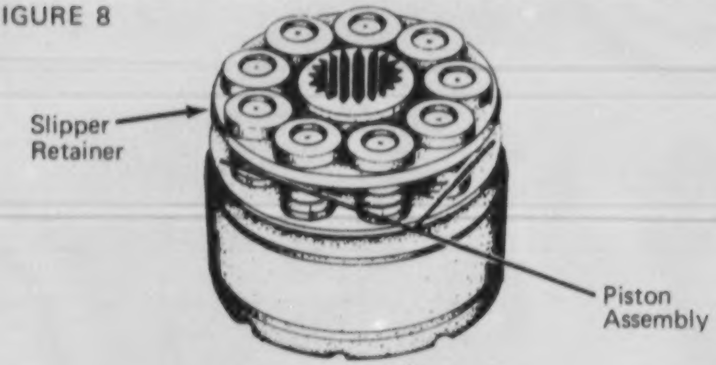
JOB SHEET #1

P. Remove motor shaft

Q. Inspect components

1. Remove piston and slipper assembly (Figure 8)

FIGURE 8

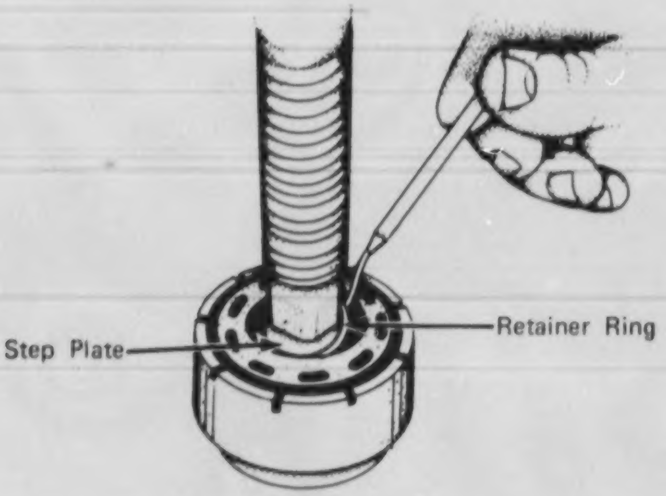

Slipper Retainer
Piston Assembly

2. Place cylinder block in a vise

3. Remove spring retainer

   (NOTE: You may need to use a step plate to compress this spring. See Figure 9)

FIGURE 9

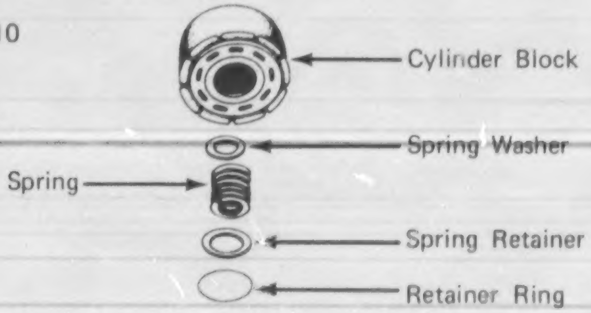

Step Plate
Retainer Ring

4. Release pressure slowly

JOB SHEET #1

5. Remove spring, retainer, and washer from block (Figure 10)

FIGURE 10


Cylinder Block
Spring Washer
Spring
Spring Retainer
Retainer Ring

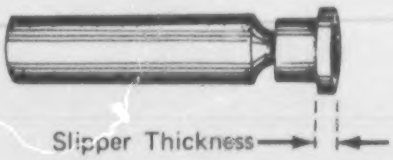
6. Clean all parts thoroughly
7. Check the spring against specifications
8. Check valve face for wear
9. Check piston fit in the bushings
10. Replace spring washer, spring and spring retainer into block
11. Compress spring and replace retainer ring
12. Wrap block in lint free cloth and set aside
13. Inspect other block
14. Remove pistons from retainer
15. Measure pistons with micrometer

    (NOTE: Compare to manufacturer's specifications.)
16. Inspect each piston for scoring, wear, and scratches

    (NOTE: Compare to manufacturer's specifications.)
17. Check slippers for wear (Figure 11)

    (NOTE: Slipper faces can be lapped; compare thickness to manufacturer's specifications.)

FIGURE 11


Slipper Thickness

JOB SHEET #1

18. Replace block and piston assembly if bores or pistons are damaged
19. Reinstall pistons in slipper retainer
20. Put pistons back in block and rewrap in cloth
21. Clean valve plate
22. Inspect valve plate
    a. Run fingernail across plate surface
    b. Replace if ridges or grooves are felt with a fingernail
23. Inspect pin slots and grooves

    (NOTE: Deburr as necessary.)
24. Inspect pump swash plate thrust plate
25. Inspect all bearings

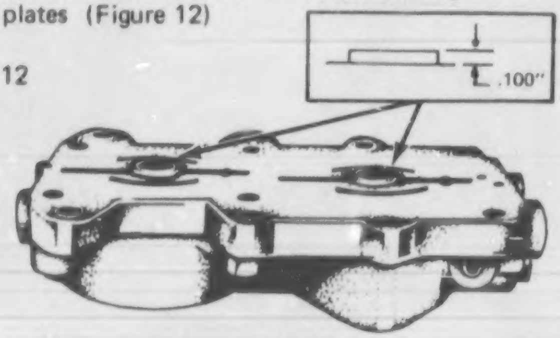
    (NOTE: Replace as necessary.)

R. Reassembly

(NOTE: Reverse disassembly procedures using points listed below.)

1. Lubricate all parts with manufacturer's recommend lubricant prior to reassembly
2. Install thin pad of pump swash plate toward top of transmission housing
3. Use all new gaskets
4. Install two notch valve plates in pump
5. Install four notch valve plates in motor
6. Install new center secton needle bearings to act as a pilot for the valve plates (Figure 12)

FIGURE 12



HYDROSTATIC DRIVES
UNIT V

NAME ______________________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. Power transfer system that uses the rotating power from the engine to drive a pump which supplies hydraulic fluid under pressure to a hydraulic motor which powers the drive wheels through a differential and/or transmission

_____b. Piston arrangement in pumps and motors where piston bores are situated in straight lines along the cylinder's axis

_____c. Piston arrangement in pumps and motors where the piston bores are at a 90° angle to the cylinder axis

_____d. Smaller low pressure pump used to supply fluid to main system pump

_____e. Control and relief valves used in high and low pressure circuits (before and after motor) to protect system from damage due to surges caused by sudden movement of the control lever

1. Charge pump
2. Radial piston
3. Hydrostatic drive
4. Acceleration valves
5. Axial piston

2. Identify the common hydrostatic drive system components.

a. ____________________

b. ____________________

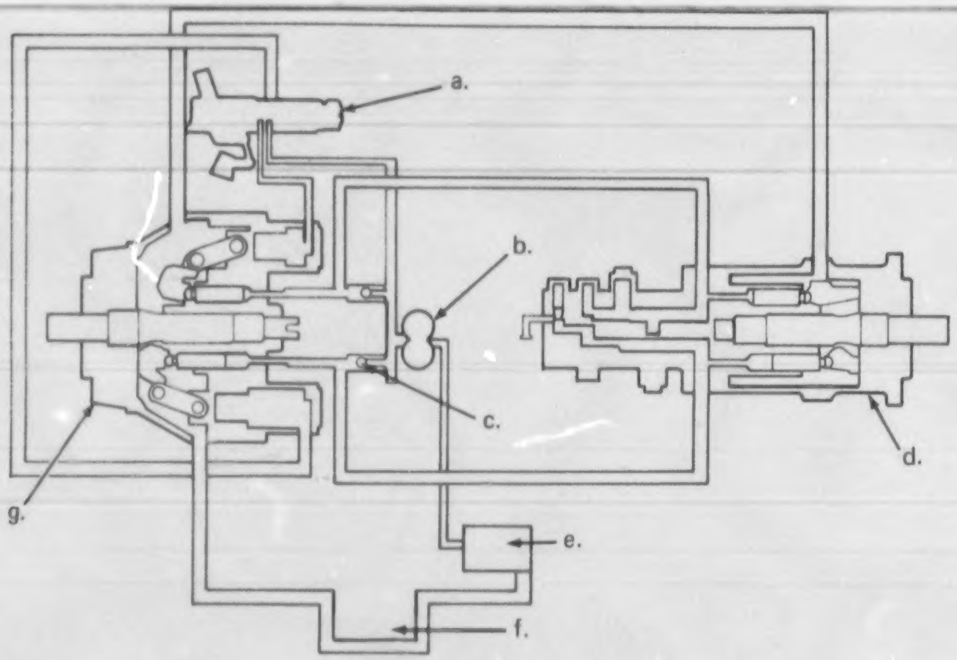
c. ____________________

d. ____________________

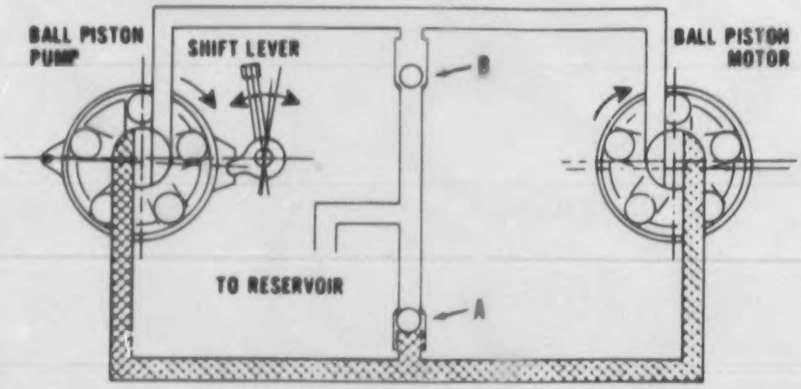
e. ____________________

f. ____________________

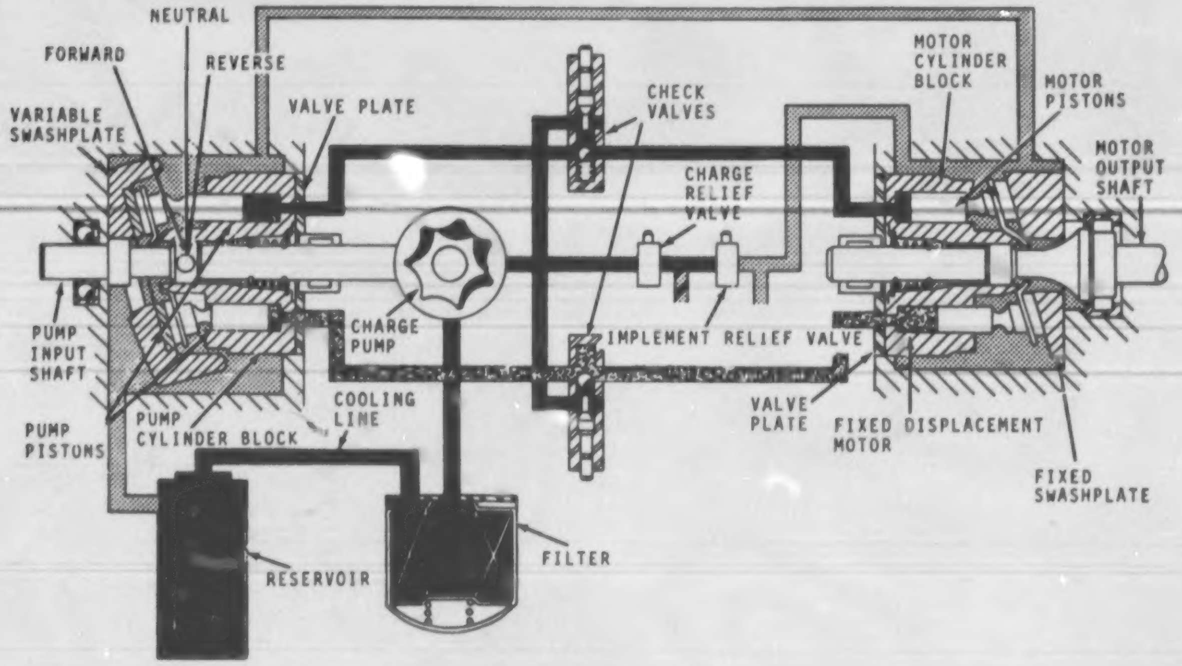
g. ____________________



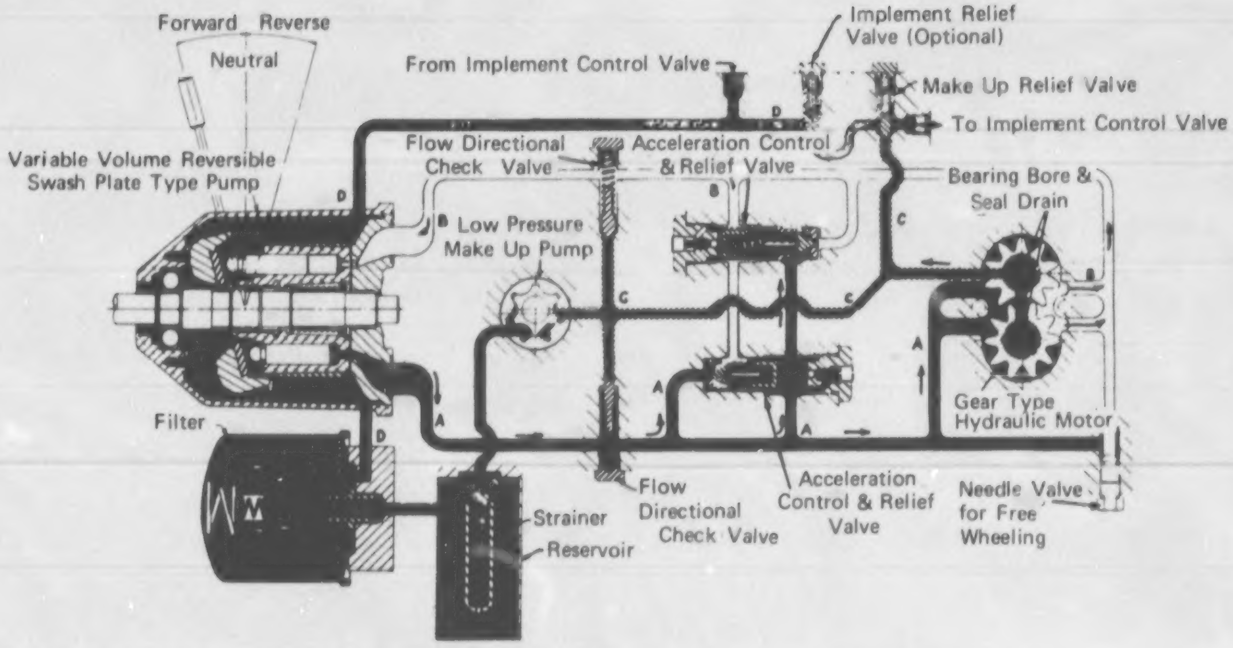
3. Identify common types of hydrostatic drive systems.


BALL PISTON PUMP
SHIFT LEVER
B
BALL PISTON MOTOR
TO RESERVOIR
A

a. ____________________


NEUTRAL
FORWARD
REVERSE
VARIABLE SWASHPLATE
VALVE PLATE
CHECK VALVES
MOTOR CYLINDER BLOCK
MOTOR PISTONS
MOTOR OUTPUT SHAFT
CHARGE RELIEF VALVE
CHARGE PUMP
IMPLEMENT RELIEF VALVE
PUMP INPUT SHAFT
PUMP PISTONS
PUMP CYLINDER BLOCK
COOLING LINE
VALVE PLATE
FIXED DISPLACEMENT MOTOR
FIXED SWASHPLATE
RESERVOIR
FILTER

b. ________________


Forward
Reverse
Neutral
Implement Relief Valve (Optional)
From Implement Control Valve
Make Up Relief Valve
To Implement Control Valve
Variable Volume Reversible Swash Plate Type Pump
Flow Directional Check Valve
Acceleration Control & Relief Valve
Bearing Bore & Seal Drain
Low Pressure Make Up Pump
Gear Type Hydraulic Motor
Filter
Strainer
Reservoir
Flow Directional Check Valve
Acceleration Control & Relief Valve
Needle Valve for Free Wheeling
A
B
C
D
G

c. ________________

4. List four common causes for system malfunctions.

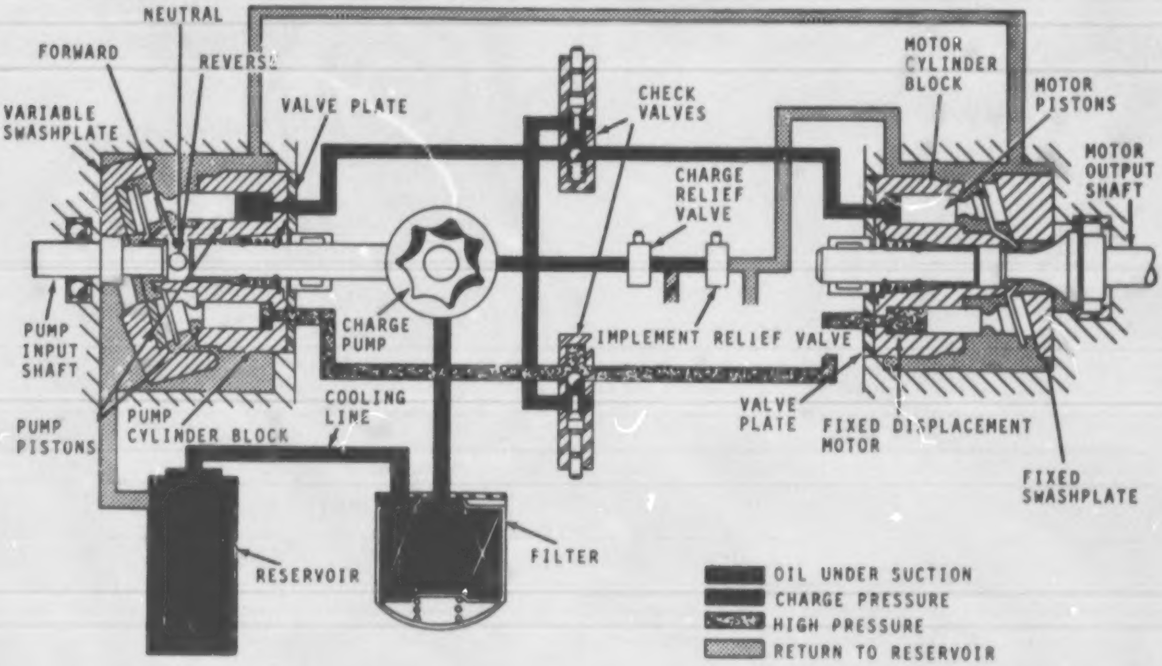
   a.

   b.

   c.

   d.

5. Describe the fluid flow through the hydrostatic system illustrated below.


NEUTRAL
FORWARD
REVERSE
VARIABLE SWASHPLATE
VALVE PLATE
CHECK VALVES
MOTOR CYLINDER BLOCK
MOTOR PISTONS
MOTOR OUTPUT SHAFT
CHARGE RELIEF VALVE
PUMP INPUT SHAFT
CHARGE PUMP
IMPLEMENT RELIEF VALVE
PUMP PISTONS
PUMP CYLINDER BLOCK
COOLING LINE
VALVE PLATE
FIXED DISPLACEMENT MOTOR
FIXED SWASHPLATE
RESERVOIR
FILTER
OIL UNDER SUCTION
CHARGE PRESSURE
HIGH PRESSURE
RETURN TO RESERVOIR

6. Demonstrate the ability to disassemble, inspect, repair, and reassemble an axial piston hydrostatic drive.

   (NOTE: If this activity has not been accomplished prior to the test, ask your instructor when it should be completed.)

HYDROSTATIC DRIVES
UNIT V

ANSWERS TO TEST

1. a. 3
   b. 5
   c. 2
   d. 1
   e. 4
2. a. Control valve
   b. Charge pump
   c. Valves
   d. Motor
   e. Filter
   f. Reservoir
   g. Pump
3. a. Radial piston to radial piston
   b. Axial piston to axial piston
   c. Axial piston to gear
4. a. Loose lines
   b. Contaminants in the system
   c. Excessive component wear
   d. Low fluid level
5. Description should include:
   a. Rotor type charge pump pulls under suction
   b. Charge pump pressures fluid through check valve on pump inlet side

   (NOTE: Swash plate tilt determines inlet and outlet.)

   c. Pump increases pressure and fluid flow volume

   d. Fluid enters motor under high pressure

   e. Fluid pressure rotates shaft and low pressure fluid returns to reservoir and pump

6. Performance skill evaluated to the satisfaction of the instructor.

FRONT AXLES AND STEERING
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to name the components of the front axle and steering gears and identify the types of steering mechanisms. The student should also be able to match the types of wheel bearings to the maintenance requirements and demonstrate the ability to disassemble, service, and reassemble a front axle and steering gear. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with front axles and steering to the correct definitions.
2. Name the six major components of a front axle assembly.
3. Identify the types of steering mechanisms.
4. Name the nine major components of a cam and pin steering gear.
5. Match the types of wheel bearings to the correct maintenance requirements.
6. Discuss front end alignment.
7. Demonstrate the ability to:
    a. Disassemble, inspect, and reassemble front axle and adjust toe-in.
    b. Remove, disassemble, inspect, assemble, and reinstall steering gear.

FRONT AXLES AND STEERING
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.
  B. Provide student with information and job sheets.
  C. Make transparencies.
  D. Discuss unit and specific objectives.
  E. Discuss information sheet.
  F. Demonstrate and discuss the procedures outlined in the job sheets.
  G. Give comparative demonstration on the differences and similarities between types of steering mechanisms.
  H. Use toe-in model if available.
  I. Give test.

II. Student:

  A. Read objective sheet.
  B. Study information sheet.
  C. Complete job sheets.
  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet
  B. Information sheet
  C. Transparency masters
    1. TM 1--Front Axle Components
    2. TM 2--Steering Mechanism Types

3. TM 3--Steering Gear Components
4. TM 4--Wheel Bearings
5. TM 5--Alignment

D. Job sheets

1. Job Sheet #1--Disassemble, Inspect, and Reassemble Front Axle and Adjust Toe-In
2. Job Sheet #2--Remove, Disassemble, Inspect, Assemble, and Reinstall Steering Gear

E. Test

F. Answers to test

II. References:

A. *Small Tractor Service Manual.* Vol. 2. Kansas City, Missouri: Technical Publications Division/Intertec Publishing Co., 1975.

B. *Bearings and Seals.* Moline, Illinois: John Deere Service Publications, 1974.

FRONT AXLES AND STEERING
UNIT I

INFORMATION SHEET

I. Terms and definitions

A. Steering knuckle--Pivoting member of the steering linkage to which the wheels are attached

B. Tie rod--Rod that connects the steerable wheels and insures that they remain parallel

(NOTE: This rod may be adjustable.)

C. Worm gear--Gear whose teeth resemble the threads on a screw

D. Quadrant gear--Device or mechanical part with gear teeth that is in the shape of 1/4 to 1/2 circle

E. Drag link--Rod or link that connects the steering gear to the steerable wheels and transmits the steering motion

F. Rack and pinion--Steering mechanism consisting of a bar with teeth on one face for gearing with a pinion or spur gear

G. Toe-in--Adjustment of the steerable wheels so that they are closer together at the front than they are at the rear

H. Caster--Adjustment of the steerable wheels so that they tend to remain in the straight ahead position

I. Camber--Adjustment of the wheels so that they are closer at the bottom than at the top

II. Components of front axle assembly (Transparency 1)

A. Axle main member

B. Steering knuckles

C. Tie rod

D. Pivot pin

E. Tie rod end

F. Drag link arm (steering arm)

INFORMATION SHEET

III. Types of steering mechanisms (Transparency 2)

  A. Worm and pin
  B. Quadrant gear
  C. Cam
  D. Direct link
  E. Rack and pinion

IV. Major components of cam and pin steering gear (Transparency 3)

  A. Steering wheel
  B. Steering shaft
  C. Steering gear housing
  D. Bearings
  E. Adjustable end cap
  F. Steering arm
  G. Cam follower pin and locknut
  H. Drag link
  I. Drag link end

V. Types of wheel bearings and maintenance requirements (Transparency 4)

  A. Bushings--Lube regularly with engine oil
  B. Ball bearings--Pack periodically with grease
  C. Roller bearings--Pack periodically with grease

VI. Front end alignment (Transparency 5)

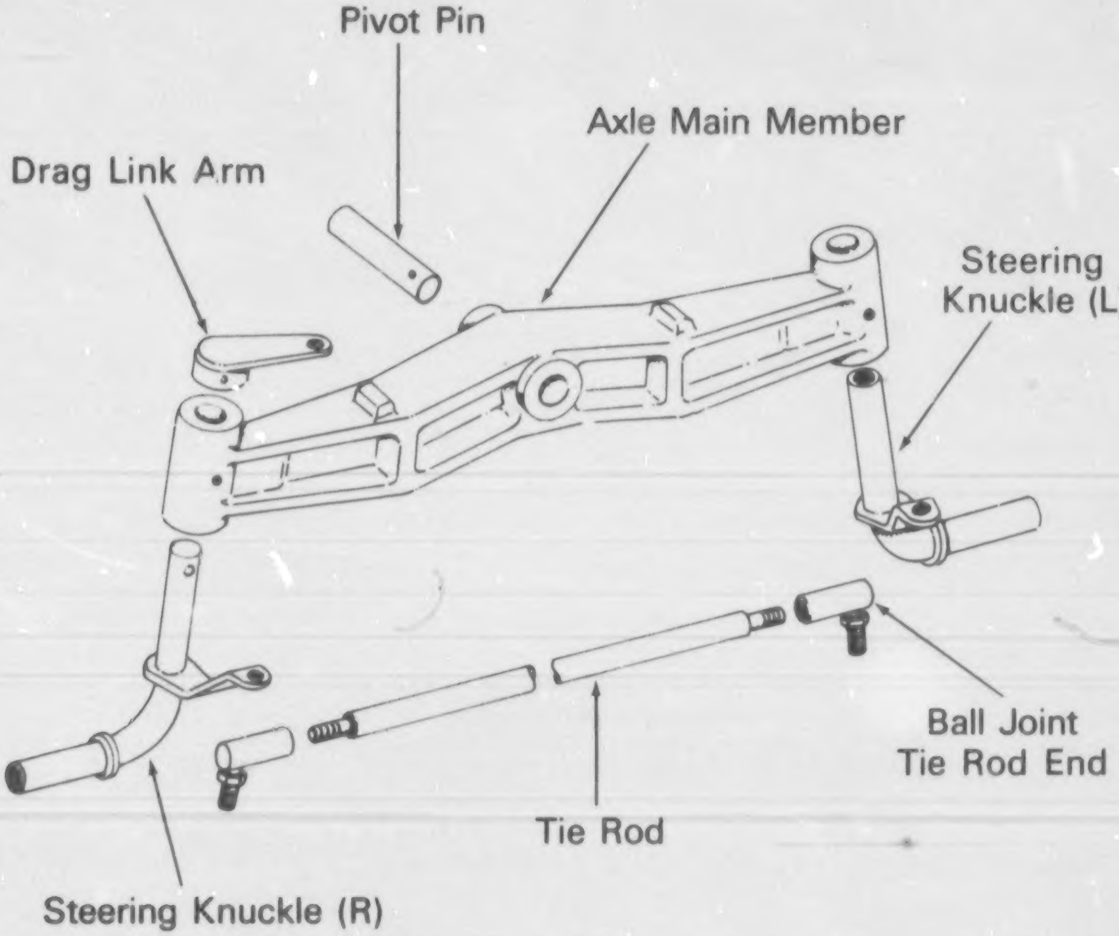
  A. Caster and camber
    1. Preset
    2. Not adjustable

INFORMATION SHEET

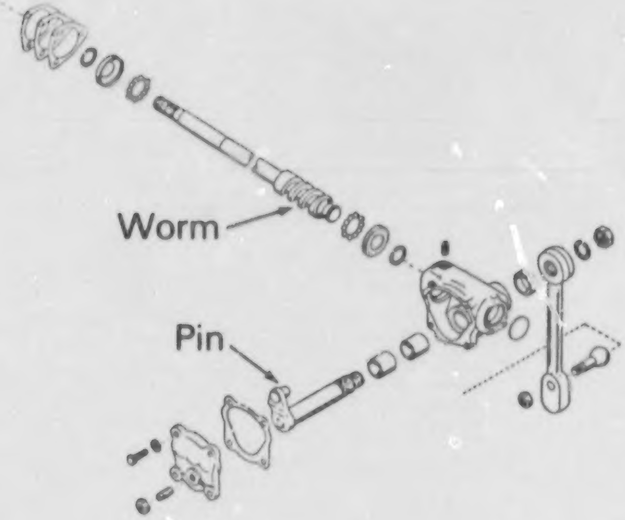
B. Toe-in

1. Adjustable
2. Wheels 1/8" closer together at front than at rear
3. Measurement taken hub high between inside edges of wheels

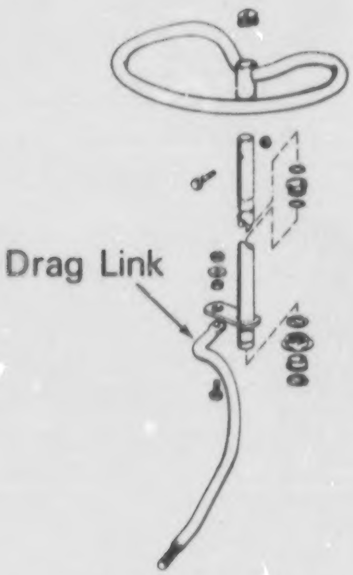
Front Axle Components


Pivot Pin
Axle Main Member
Drag Link Arm
Steering Knuckle (L)
Ball Joint Tie Rod End
Tie Rod
Steering Knuckle (R)

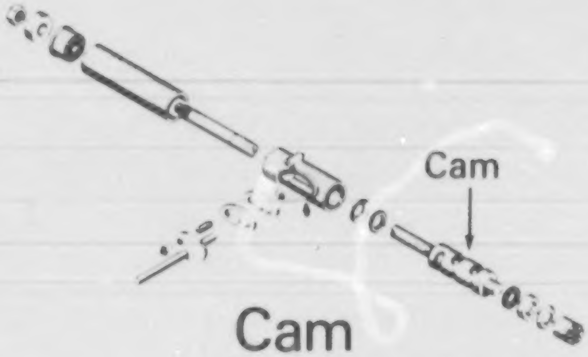
Steering Mechanism Types



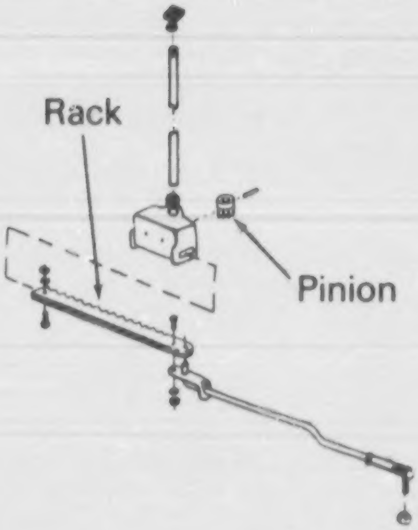
Worm and Pin



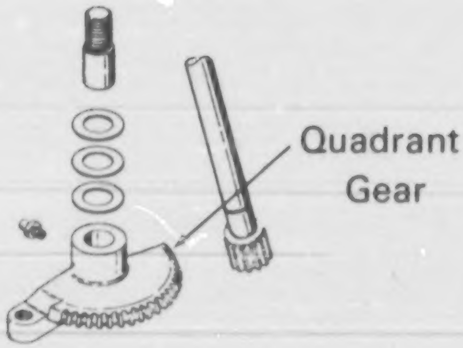
Direct Link



Cam

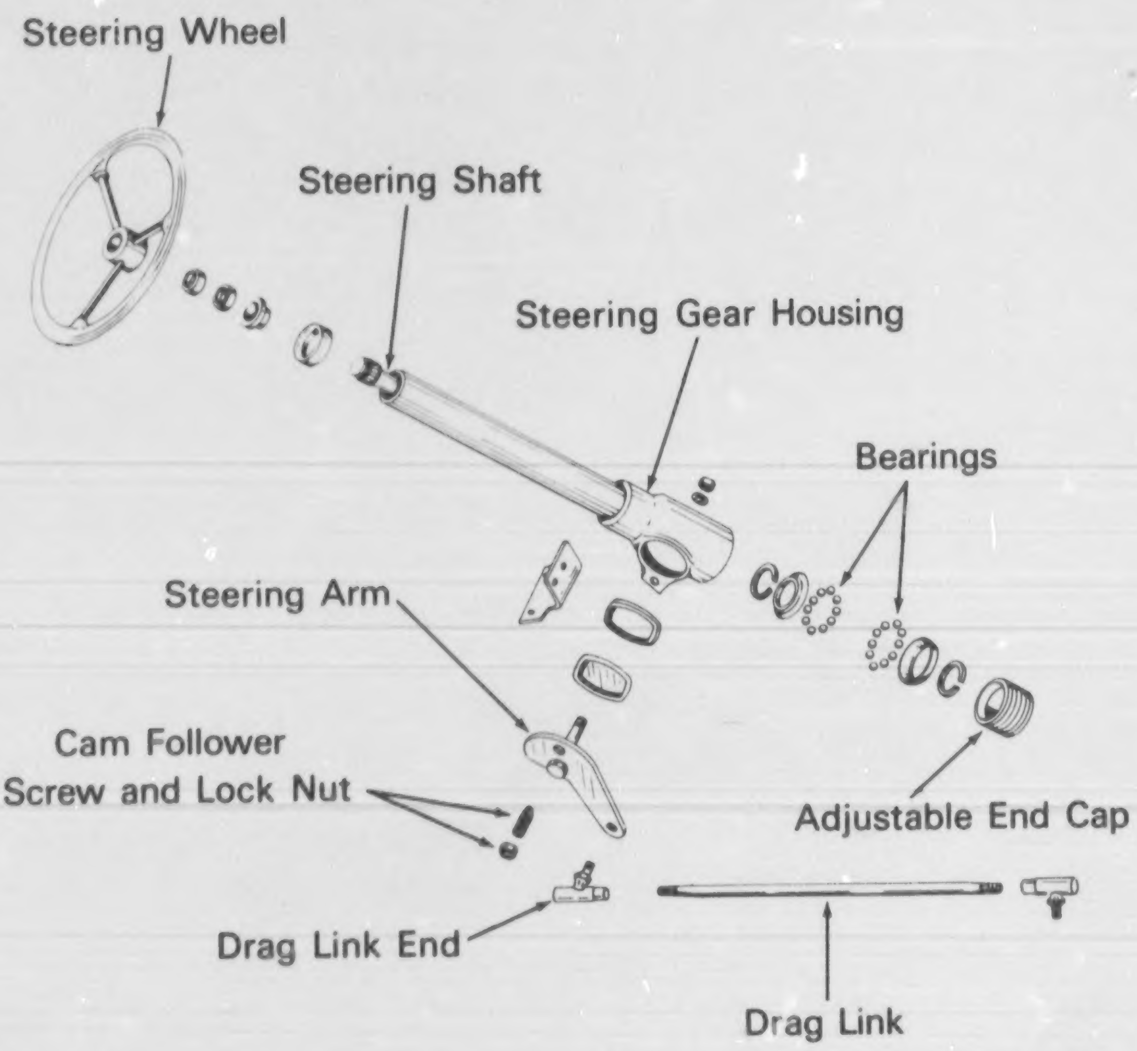

Rack
Pinion

Rack and Pinion

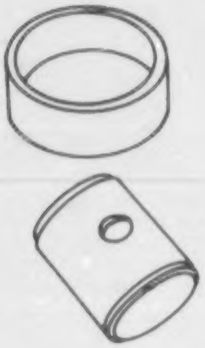

Quadrant Gear

Quadrant Gear

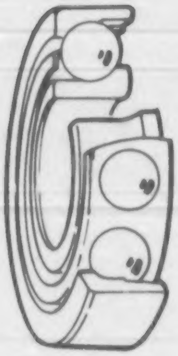
Steering Gear Components


Steering Wheel
Steering Shaft
Steering Gear Housing
Bearings
Steering Arm
Cam Follower
Screw and Lock Nut
Adjustable End Cap
Drag Link End
Drag Link

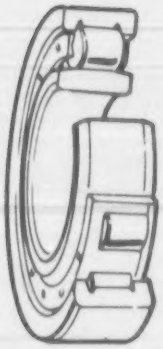
Wheel Bearings



Bushings

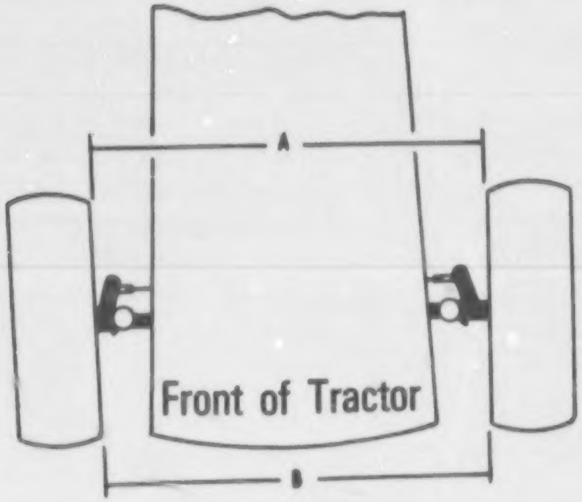


Ball Bearing



Roller Bearing

Alignment


A
Front of Tractor
B

Toe—in is correct when distance 'B' is 1/8" inch less than distance 'A' with both measurements taken at hub height.

FRONT AXLES AND STEERING
UNIT I

JOB SHEET #1--DISASSEMBLE, INSPECT, AND REASSEMBLE FRONT AXLE AND ADJUST TOE-IN

I. Tools and materials

- A. Hand tool assortment
- B. Tape measure
- C. Wood blocks
- D. Multipurpose grease
- E. Appropriate service manual
- F. Tie rod end removing tool (pickle fork)

II. Procedure

- A. Disconnect spark plug wire and connect to ground
- B. Block up front of tractor with wood blocks so that front wheels do not touch the ground
- C. Remove cotter pins or axle nuts and front wheels
- D. Disconnect drag link
- E. Remove tie rod
- F. Remove steering knuckles according to instructions in appropriate service manual
- G. Remove axle main member pivot pin
- H. Remove axle main member
- I. Inspect axle pivot pin and pivot bushing for wear and replace, if necessary
- J. Inspect steering knuckles and bushings for wear and replace, if necessary
- K. Inspect tie rod and drag link ends for excessive play
- L. Inspect front wheel bushings or bearings for excessive wear
- M. Repack front wheel bearings with multipurpose grease
- N. Position axle main member under chasses and install pivot pin

JOB SHEET #1

O. Install and secure steering knuckles according to istructions in service manual

(NOTE: Be sure to lube axle pivot and steering knuckles on assembly.)

P. Install tie rod

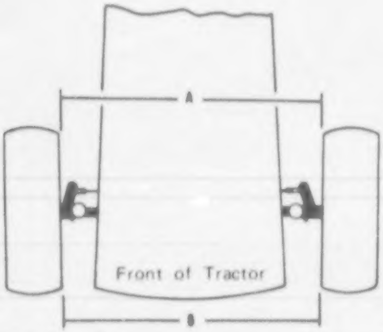
Q. Connect drag link

R. Install front wheels and secure according to instructions in service manual

S. Remove blocks and lower vehicle to the ground

T. Adjust toe-in by adjusting length of the tie rod (Figure 1)

FIGURE 1



Toe-in is correct when distance "B" is 1/8-inch less than distance "A" with both measurements taken at hub height

FRONT AXLES AND STEERING
UNIT I

JOB SHEET #2--REMOVE, DISASSEMBLE, INSPECT, ASSEMBLE, AND REINSTALL STEERING GEAR

I. Tools and materials

- A. Hand tool assortment
- B. Multipurpose grease
- C. Appropriate service manual

II. Procedure

(NOTE: Consult appropriate service manual for the exact step-by-step operations for the vehicle you are working on.)

- A. Disconnect drag link at steering gear
- B. Remove steering wheel
- C. Remove steering gear

  (NOTE: Consult appropriate service manual for the exact procedure.)
- D. Disassemble steering gear

  (NOTE: Consult appropriate service manual for the exact procedures.)
- E. Arrange parts in order upon disassembly
- F. Inspect bearings and bearing surfaces for excessive wear
- G. Inspect cam and pin or gear teeth for excessive wear
- H. Inspect steering shaft for bent conditions
- I. Clean parts and arrange for reassembly
- J. Pack steering gear bearings with grease or lube bearing surfaces
- K. Assemble steering gear

  (NOTE: Consult appropriate manual for correct procedure.)
- L. Adjust steering gear, if necessary
- M. Install steering gear

  (NOTE: Consult appropriate service manual for correct procedure.)

JOB SHEET #2

N. Install steering wheel

O. Connect drag link to steering gear

P. Operate steering from stop to stop to check operation

FRONT AXLES AND STEERING
UNIT I

NAME ____________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. Rod that connects the steerable wheels and insures that they remain parallel

_____b. Device or mechanical part with gear teeth that is in the shape of 1/4 to 1/2 circle

_____c. Adjustment of the steerable wheels so that they are closer together at the front than they are at the rear

_____d. Rod or link that connects the steering gear to the steerable wheels and transmits the steering motion

_____e. Pivoting member of the steering linkage to which the wheels are attached

_____f. Gear whose teeth resemble the threads on a screw

_____g. Steering mechanism consisting of a bar with teeth on one face for gearing with a pinion or spur gear

_____h. Adjustment of the wheels so that they are closer at the bottom than at the top

_____i. Adjustment of the steerable wheels so that they tend to remain in the straight ahead positon

1. Rack and pinion
2. Worm gear
3. Steering knuckle
4. Caster
5. Toe-in
6. Tie rod
7. Quadrant gear
8. Camber
9. Drag link

2. Name the six major components of a front axle assembly.

   a.

   b.

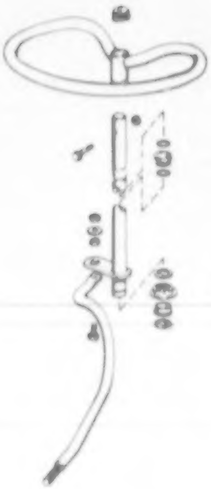
   c.

   d.

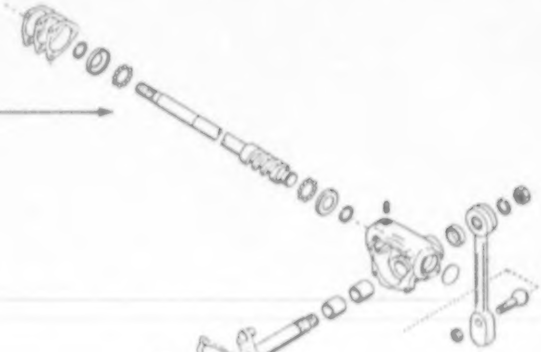
   e.

   f.

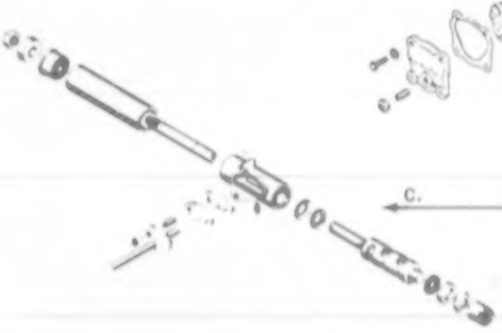
3. Identify the types of steering mechanisms.



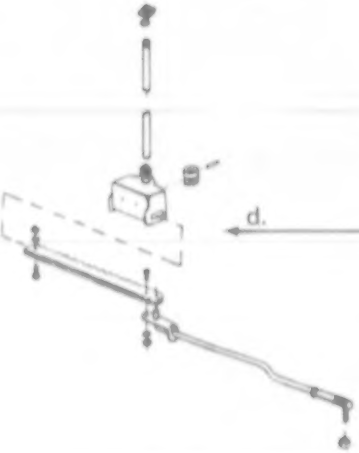
a.



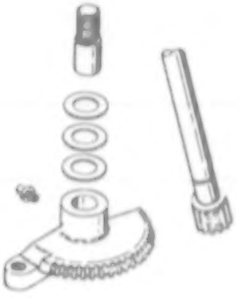
b.



c.



d.



e.

4. Name the nine major components of a cam and pin steering gear.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

   h.

   i.

5. Match the types of wheel bearings on the right to the correct maintenance requirements.

   _____a. Pack periodically with grease

   _____b. Lube regularly with engine oil

   1. Ball bearings
   2. Bushings
   3. Roller bearings

6. Discuss front end alignment.

7. Demonstrate the ability to:

   a. Disassemble, inspect, and reassemble front axle and adjust toe-in.

   b. Remove, disassemble, inspect, assemble, and reinstall steering gear.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

FRONT AXLES AND STEERING
UNIT I

ANSWERS TO TEST

1. a. 6
   b. 7
   c. 5
   d. 9
   e. 3
   f. 2
   g. 1
   h. 8
   i. 4

2. a. Axle main member
   b. Steering knuckles
   c. Tie rod
   d. Pivot pin
   e. Tie rod end
   f. Drag link arm (steering arm)

3. a. Direct link
   b. Worm and pin
   c. Cam
   d. Rack and pinion
   e. Quadrant gear

4. a. Steering wheel
   b. Steering shaft
   c. Steering gear housing
   d. Bearings
   e. Adjustable end cap
   f. Steering arm
   g. Cam follower pin and locknut

h. Drag link

i. Drag link end

5. a. 1, 3

b. 2

6. Discussion should include:

a. Caster and camber

1) Preset

2) Not adjustable

b. Toe-in

1) Adjustable

2) Wheels 1/8 " closer together at front than at rear

3) Measurement taken hub high between inside edges of wheels

7. Performance skills evaluated to the satisfaction of the instructor

EQUIPMENT DRIVES
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to select the types of equipment drives and list the uses of each type. The student should also be able to perform services and repair on the equipment drives. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with equipment drives to the correct definitions.
2. Select the types of equipment drives.
3. List typical uses of each type of equipment drive.
4. Identify the types of PTO clutches.
5. List two types of PTO power transmitting devices.
6. Describe the operation of PTO clutches.
7. List three drive chain size classifications.
8. Describe the operation of hydraulic motor equipment drives.
9. Match common types of belt failures to their causes.
10. Demonstrate the ability to:
    a. Inspect, replace, and adjust a drive belt.
    b. Remove, service, and replace a drive chain.
    c. Remove, test, and replace an electromagnetic PTO clutch.
    d. Disassemble and reassemble a PTO shaft universal joint.

EQUIPMENT DRIVES
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. Take a field trip to a shop specializing in repair of grounds keeping equipment to illustrate all types of equipment.

   H. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Equipment Drive Types

      2. TM 2--Equipment Drive Types (Continued)

      3. TM 3--PTO Clutches

4. TM 4--PTO Power Transmitting Devices

5. TM 5--Roller Type Chain

6. TM 6--Hydraulic Motor Equipment Drives

7. TM 7--Belt Failures And Causes

D. Job sheets

1. Job Sheet #1--Inspect, Replace, and Adjust a Drive Belt

2. Job Sheet #2--Remove, Service, and Replace a Drive Chain

3. Job Sheet #3--Remove, Test, and Replace an Electromagnetic PTO Clutch

4. Job Sheet #4--Disassemble and Reassemble a PTO Shaft Universal Joint

E. Test

F. Answers to test

II. References:

A. *John Deere Service Manual - 60 and 70 Lawn Tractors.* Moline, Illinois: Deere and Co., 1970.

B. *Grounds Keeping Equipment.* Vol. 1. Athens, Georgia: American Association for Vocational Instructional Materials, 1974.

C. *Small Tractor Service Manual.* Vol. 1. Kansas City, Missouri: Technical Publications Division/Intertec Publishing Corp., 1975.

D. *Small Tractor Service Manual.* Vol. 2. Kansas City, Missouri: Technical Publications Division/Intertec Publishing Corp., 1975.

E. *Selecting and Maintaining Field Mowers.* Athens, Georgia: American Association for Agricultural Engineering and Vocational Agriculture, 1965.

EQUIPMENT DRIVES
UNIT I

INFORMATION SHEET

I. Terms and definitions

   A. Power take off (PTO)--Source of power to operate equipment attached to the tractor

   B. Field coil--Coil of an electromagnet which produces the magnetic field when current is passed through it

   C. Universal joint (U-joint)--Coupling device capable of transmitting rotation between two shafts not in direct alignment

   D. Pitch--Measurement from center to center of pins of drive chain

   E. Electromagnet--Core of magnetic material surrounded by a coil of wire through which an electrical current is passed to magnetize the core

   F. Width--Measurement between insides of inner plates of drive chain

II. Types of equipment drives (Transparencies 1 and 2)

   A. Belt

   B. Chain

   C. PTO shaft

   D. Ground drive

   E. Hydraulic motor

   F. Electric motor

III. Typical uses of types of equipment drives (Transparencies 1 and 2)

   A. Belt

      1. Mower

      2. Sprayer

   B. Chain

      1. Snow throwers

      2. Walk-behind tillers

INFORMATION SHEET

C. PTO shaft

1. Thatchers

2. Tractor mounted tillers

D. Ground drive

1. Seed spreader

2. Reel type mowers

E. Hydraulic motor--Mowers

F. Electric motor--Mowers

IV. Types of PTO clutches (Transparency 3)

A. Manual

1. Spring activated

2. Lever activated

B. Electromagnetic

V. Types of PTO power transmitting devices (Transparency 4)

A. Shaft

(NOTE: The shaft type may be used either with a U-joint or a right angle drive.)

B. Belt

VI. Operation of PTO clutches

A. Spring activated manual clutch

1. Spring tension keeps clutch engaged

2. Operator overrides spring tension to disengage clutch

B. Lever activated manual clutch

1. Engagement pressure maintained by pressure exerted by position of clutch mechanism

2. Operator relieves tension on clutch mechanism to disengage clutch

INFORMATION SHEET

C. Electromagnetic clutch

  1. Electric current passing through field coil creates strong magnetic field
  2. Strong magnetic field holds clutch halves in close contact
  3. Operator controls electric current to field coil

VII. Drive chain size classifications (Transparency 5)

  A. Pitch
  B. Width
  C. Roller diameter

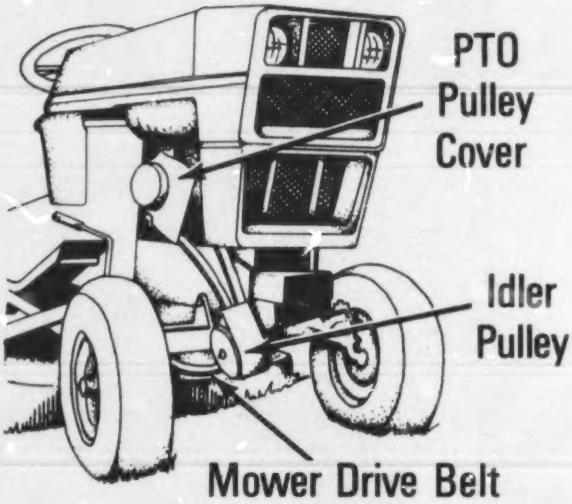
VIII Operation of hydraulic motor equipment drives (Transparency 6)

  A. Tractor engine drives hydraulic pump to pressurize fluid
  B. Pressurized fluid flows through flexible hoses to hydraulic motor mounted on equipment
  C. Fluid operates hydraulic motor to power equipment

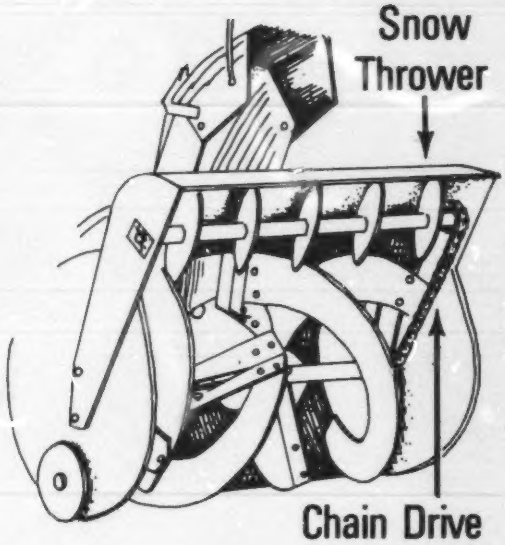
IX. Common types of belt failures and causes (Transparency 7)

  A. Belt flip-over
    1. Improper pulley alignment
    2. Excessive belt speed
  B. Edge cord breakage--Improper pulley alignment
  C. Excessive wear on top edge only--Rough pulley surfaces
  D. Excessive glaze or baking of sides--Insufficient tension
  E. Uneven belt wear on one side--Improper pulley alignment
  F. Belt disintegration--Excessive belt speed
  G. Cracks between cogs--Excessive age

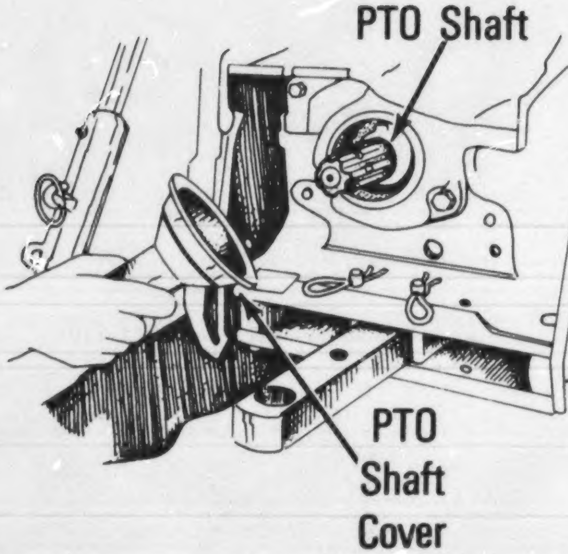
Equipment Drive Types


PTO Pulley Cover
Idler Pulley
Mower Drive Belt

- Belt

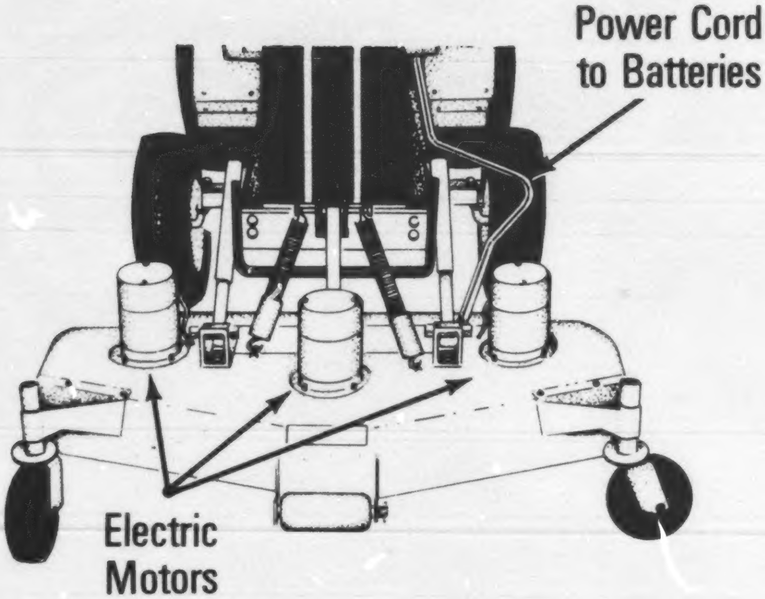

Snow Thrower
Chain Drive

- Chain


PTO Shaft
PTO Shaft Cover

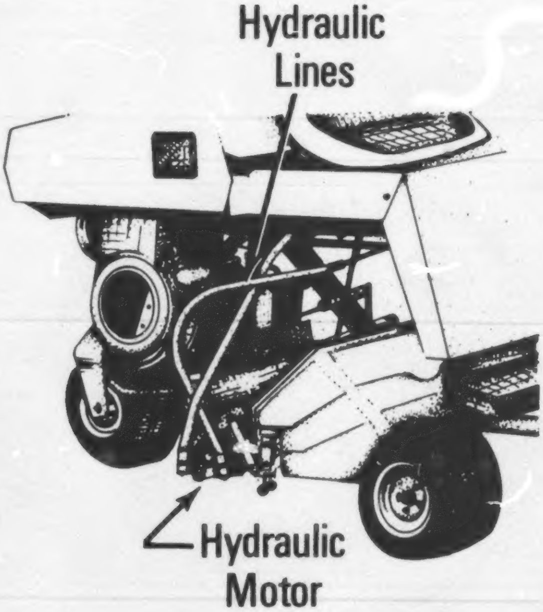
- P.T.O.

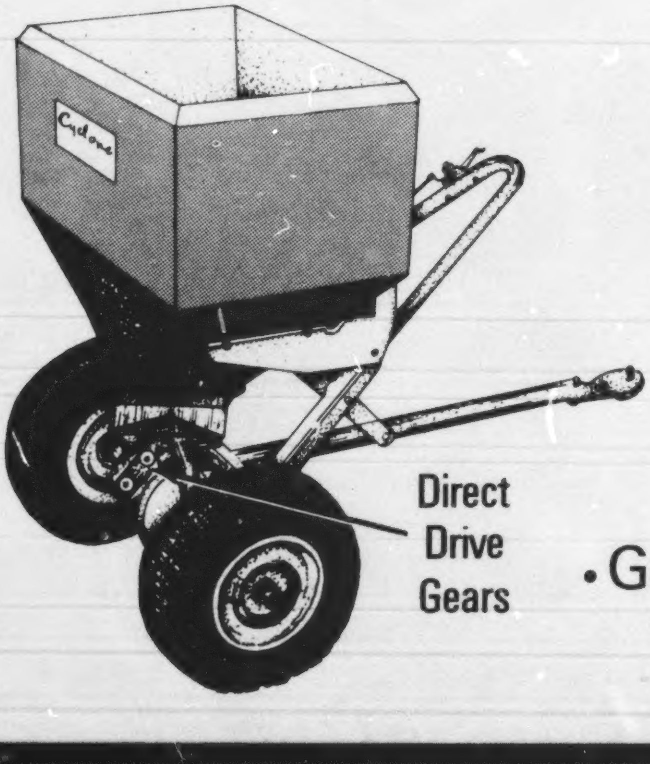
Equipment Drive Types


Power Cord
to Batteries
Electric
Motors

- Electric Motor

Hydraulic •

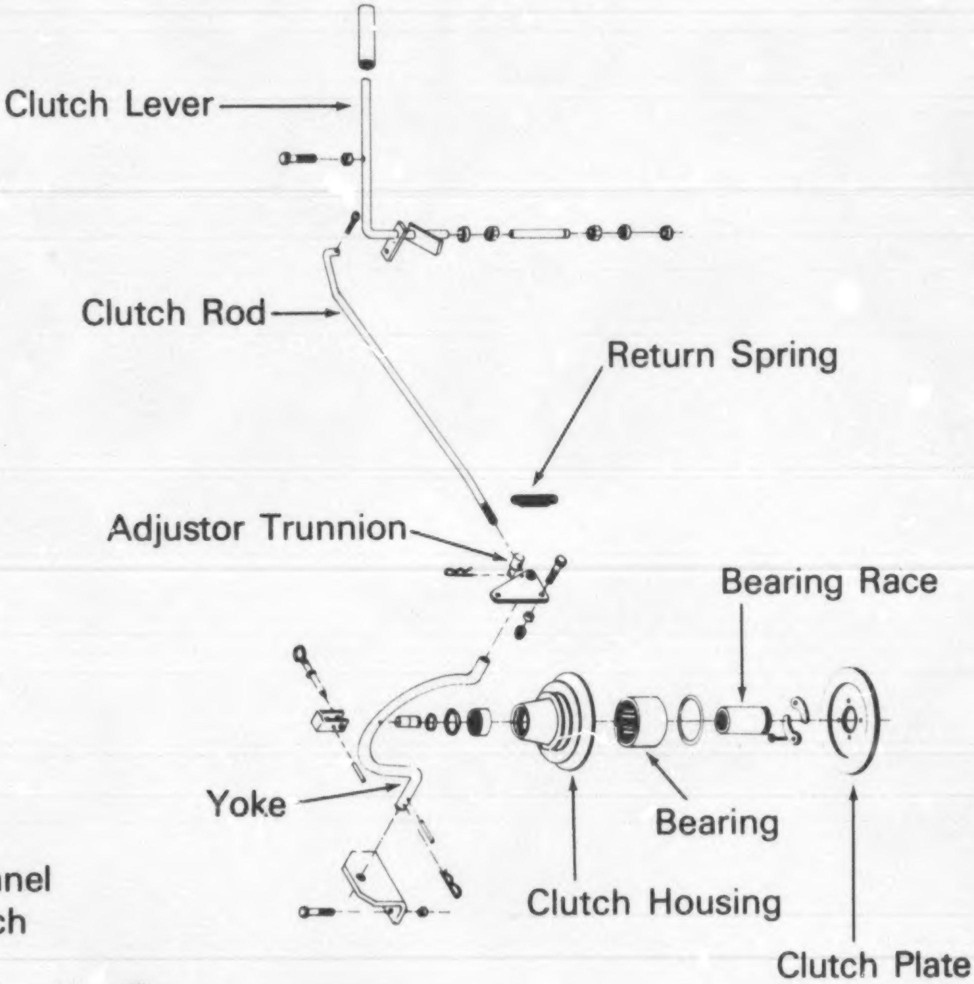

Hydraulic
Lines
Hydraulic
Motor

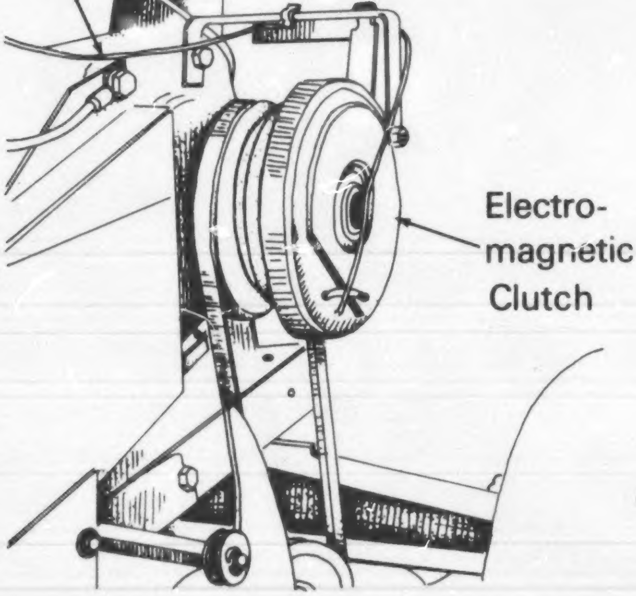

Cyclone
Direct
Drive
Gears

- Ground Drive

PTO Clutches

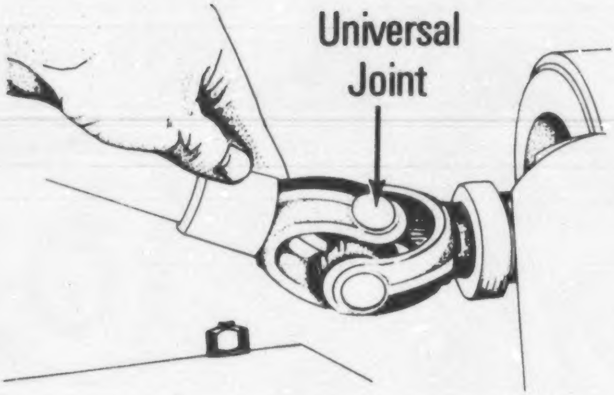
Manual •

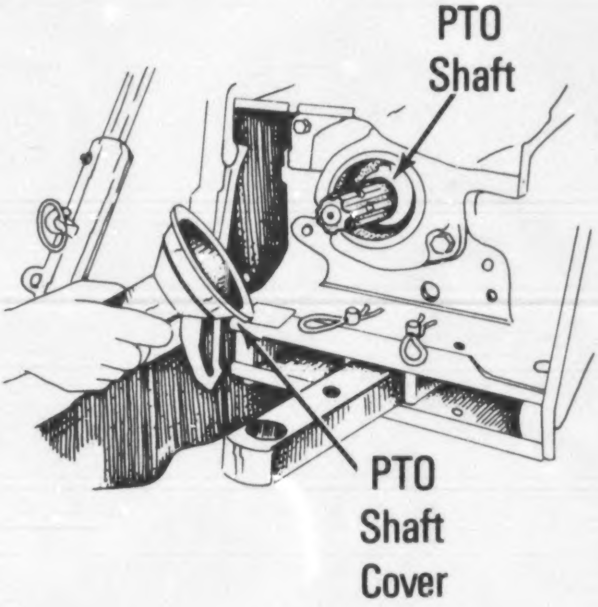

Clutch Lever
Clutch Rod
Return Spring
Adjustor Trunnion
Bearing Race
Yoke
Bearing
Clutch Housing
Clutch Plate

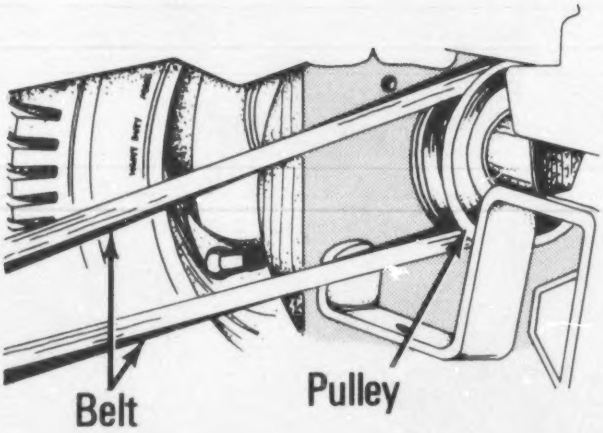

Wire to Instrument Panel Control Switch
Electro-magnetic Clutch

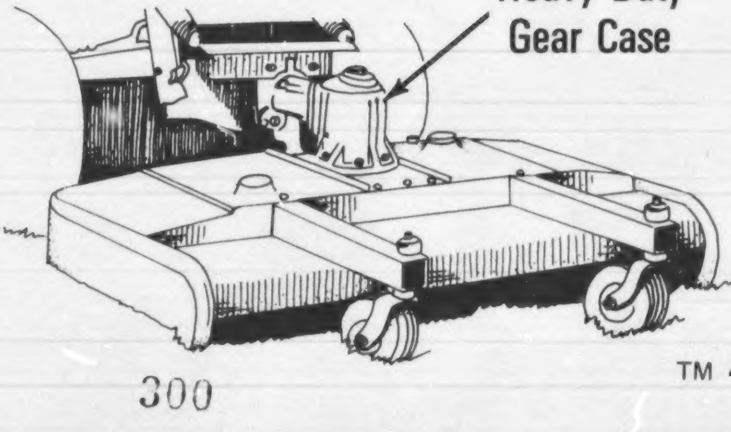
• Electromagnetic

PTO Power Transmitting Devices

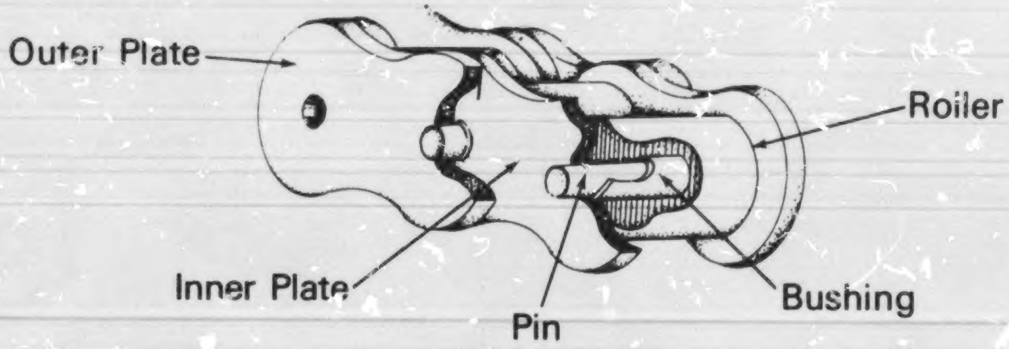

Universal Joint

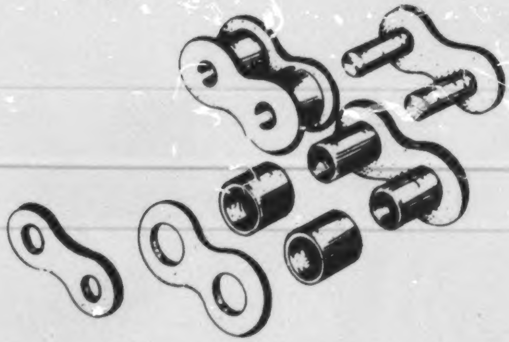

PTO Shaft
PTO Shaft Cover


Belt
Pulley

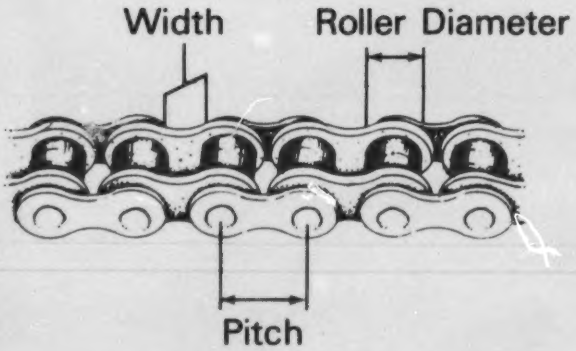

Heavy Duty Gear Case

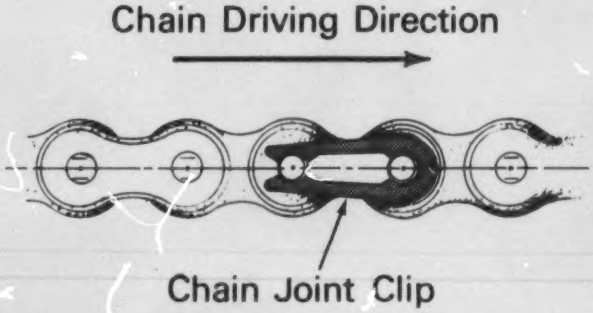
Roller Type Chain


Outer Plate
Roller
Inner Plate
Pin
Bushing



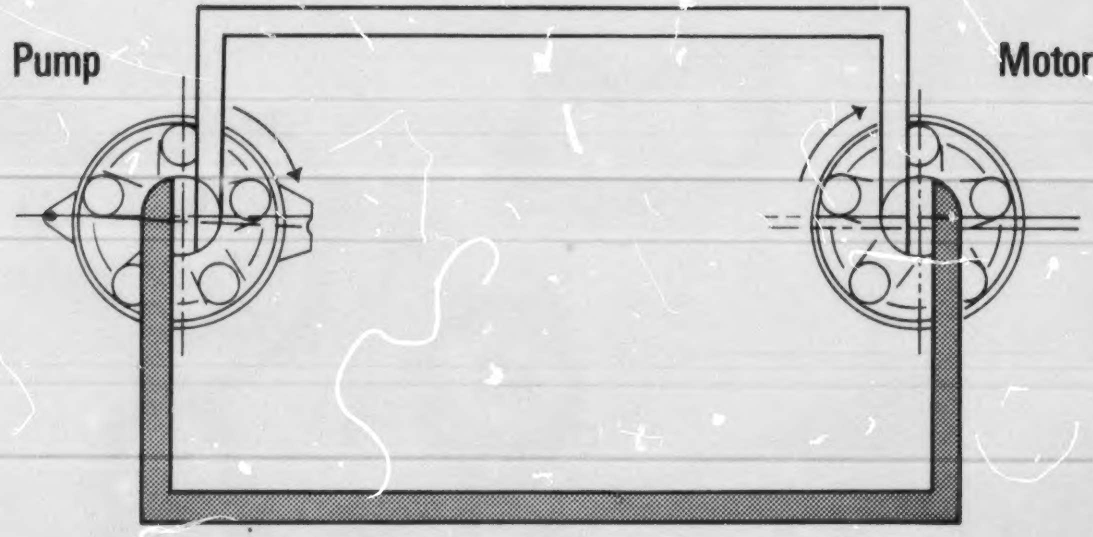
Enlarged View of Chain Construction


Width
Roller Diameter
Pitch


Chain Driving Direction
Chain Joint Clip

Install the Drive Chain Master Link Clip with the Closed End Facing the Normal Direction of Chain Rotation.

Hydraulic Motor Equipment Drives



■ High Pressure Oil

☐ Reservoir Oil

Belt Failures and Causes

A. Belt Flip-over → 1. Improper Pulley Alignment
→ 2. Excessive Belt Speed

B. Edge Cord Breakage → 1. Improper Pulley Alignment

C. Excessive Wear Only on Top Edge → 1. Rough Pulley Surfaces

D. Excessive Glaze or Baking of Sides → 1. Insufficient Tension

E. Uneven Belt Wear on One Side → 1. Improper Pulley Alignment

F. Belt Disintegration → 1. Excessive Belt Speed

G. Cracks Between Cogs → 1. Excessive Age

EQUIPMENT DRIVES
UNIT I

JOB SHEET #1--INSPECT, REPLACE, AND ADJUST A DRIVE BELT

I. Tools and materials

- A. Hand tool assortment
- B. Appropriate service manual

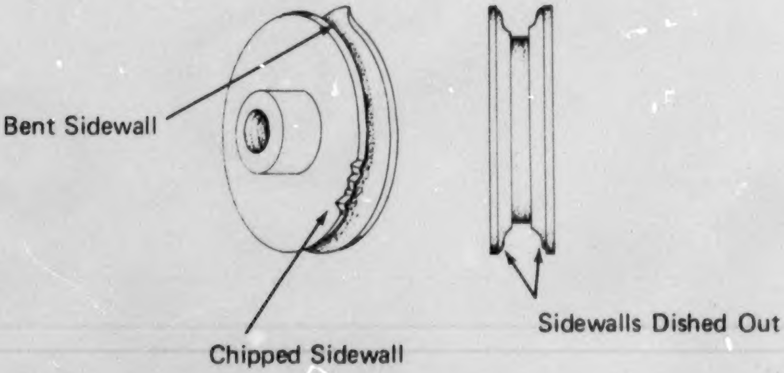
II. Procedure

(NOTE: Consult appropriate manual for exact procedure for the make and model of euqipment you are working on.)

- A. Disconnect spark plug wire and connect to ground
- B. Remove belt guards and shields, as necessary
- C. Release belt tensioning devices
- D. Remove PTO belt

  (NOTE: Never pry belts over edge of pulley. This may break belt cords and shorten the belt life.)
- E. Inspect belt for swells or lumps, breaks, and broken cords
- F. Inspect drive pulleys for damage, excessive wear, and alignment and replace, if necessary (Figure 1)

FIGURE 1



JOB SHEET #1

G. Inspect idler springs and replace if stretched or damaged

H. Install drive belt

(NOTE: If new belt is installed, be sure to use recommended V-belts of the proper length.)

I. Adjust belt tension to manufacturer's specifications

(NOTE: More belts fail from undertension than from overtension. Loose belts slip, heat, and burn, causing premature failure. Excessive belt tension stretches and weakens belts.)

J. Connect battery

K. Start engine and test operation of belt drive

EQUIPMENT DRIVES
UNIT I

JOB SHEET #2--REMOVE, SERVICE, AND REPLACE A DRIVE CHAIN

I. Tools and materials

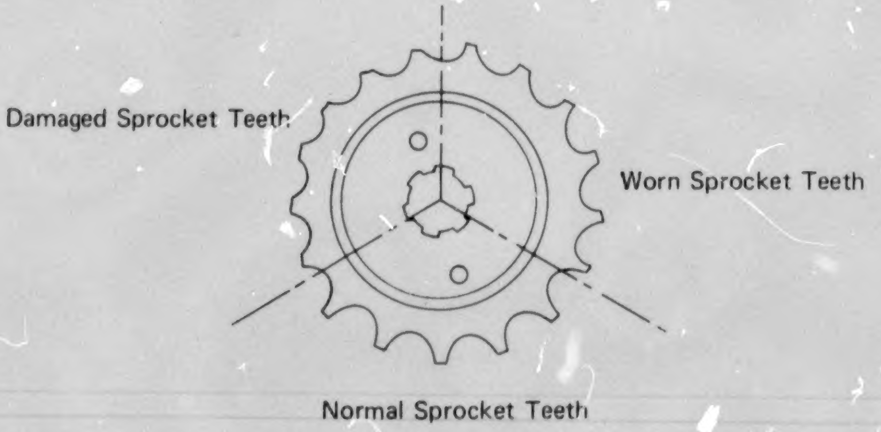
- A. Hand tool assortment
- B. Appropriate service manual
- C. Commercial chain grease
- D Cleaning solvent
- E. Cleaning pan

II. Procedure

(NOTE: Consult appropriate service manual for exact procedure for make and model of equipment you are working on.)

- A. Disconnect spark plug wire and connect to ground
- B. Remove chain guards or housings
- C. Locate and remove drive chain master link
- D. Remove drive chain
- E. Inspect chain sprockets for wear and damage (Figure 1)

FIGURE 2


Damaged Sprocket Teeth
Worn Sprocket Teeth
Normal Sprocket Teeth

JOB SHEET #2

F. Check drive chain for excessive wear and stretch

1. Lay the chain on a flat surface and stretch it to its full length and measure it
2. Compress the chain as short as possible without bending or kinking the chain and measure it
3. Subtract the shortened length from the stretched length; the difference is that amount of stretch

   (NOTE: The rule of thumb is there should not be more than 1/4 inch of stretch per foot of chain.)

   Example: A 4 foot chain should not have a stretch of more than 1 inch in length

G. Soak and wash chain thoroughly in a pan of cleaning solvent

(CAUTION: Do not use gasoline.)

H. Dry solvent from chain

I. Treat chain with commercial chain grease according to instructions included with the grease

(NOTE: Follow manufacturer's recommendations on lubrication.)

J. Install drive chain

K. Install chain guards or housings

L. Connect battery, if applicable

M. Start engine and test operation of chain drive

EQUIPMENT DRIVES
UNIT I

JOB SHEET #3--REMOVE, TEST, AND REPLACE AN ELECTROMAGNETIC PTO CLUTCH

I. Tools and materials

- A. Hand tool assortment
- B. Voltmeter
- C. Ohmmeter
- D. Torque wrench

II. Procedure

(NOTE: Consult appropriate service manual for exact procedure for the make and model of equipment you are working on.)

- A. Disconnect clutch wire
- B. Remove retaining bolt
- C. Remove clutch from shaft using recommended puller
- D. Test voltage at clutch
  - 1. Connect one lead of voltmeter to clutch wire
  - 2. Connect the other lead to ground according to battery polarity

    Example: If battery is negative (-) ground, connect negative (-) voltmeter lead to ground and the positive (+) lead to the clutch wire. Reverse the connections if battery polarity is reversed
- E. Turn on ignition and activate PTO

  (NOTE: Voltage should be same as battery. If reading is zero (0), check for a broken wire or bad switch. If voltage is between zero (0) and rated battery voltage, check for poor connection or weak battery.)
- F. Calibrate the ohmmeter
- G. Test continuity of field coil with ohmmeter
  - 1. Connect one lead of ohmmeter to wire on clutch
  - 2. Connect the other lead to the clutch hub

    (NOTE: Ohmmeter reading should be zero (0). If reading is infinity (00), field coil is defective and should be replaced.)

JOB SHEET #3

H. Rotate clutch assembly rapidly and listen for rough or damaged bearings

I. Install clutch on PTO shaft

J. Install retaining bolt and torque to specifications

K. Connect clutch wire

L. Start engine and test operation of electromagnetic PTO clutch

EQUIPMENT DRIVES
UNIT I

JOB SHEET #4--DISASSEMBLE AND REASSEMBLE A PTO SHAFT UNIVERSAL JOINT

I. Tools and materials

A. Hand tool assortment

B. Multipurpose grease

C. Vise jaw protectors

D. Brass drift punch

II. Procedure

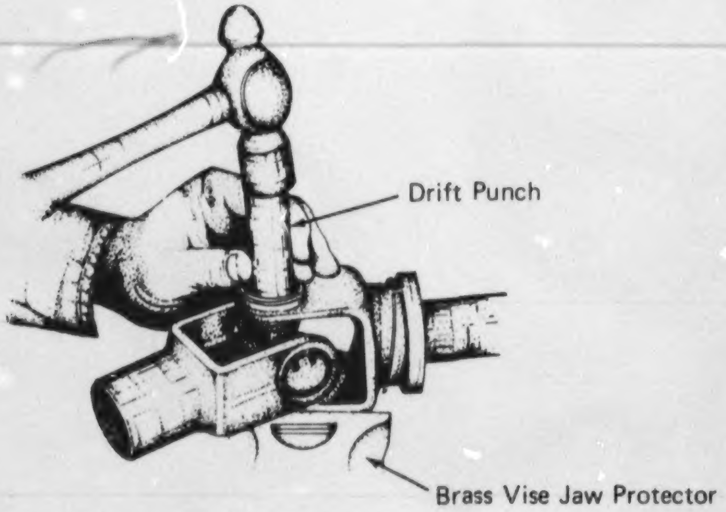
A. Remove PTO shaft

B. Place U-joint yoke in a vise

(NOTE: Use vise jaw protector to prevent scoring the machined surfaces of the U-joint.)

C. Release pressure against snap rings by tapping sharply on bearing cups with brass drift punch (Figure 1)

FIGURE 1

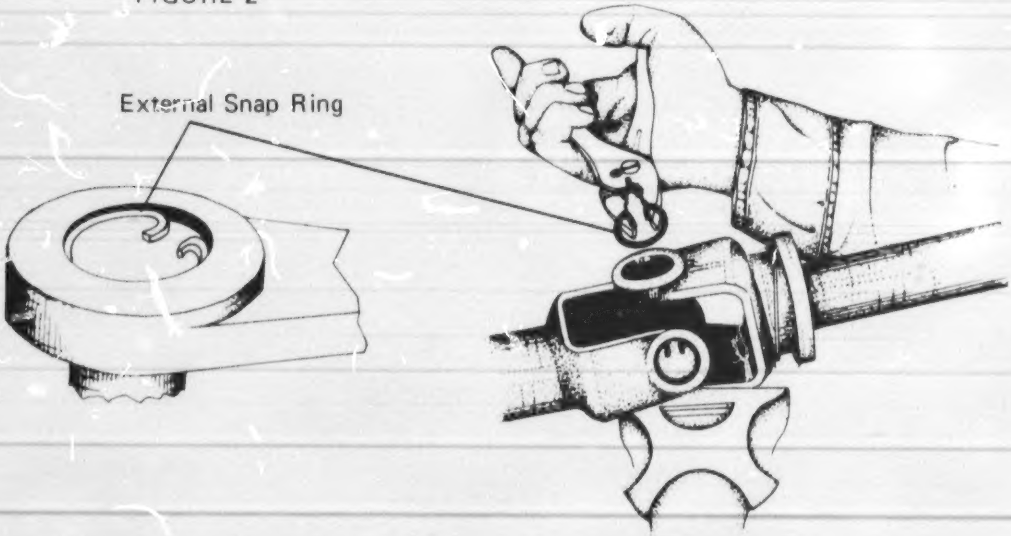


JOB SHEET #4

D. Remove snap ring

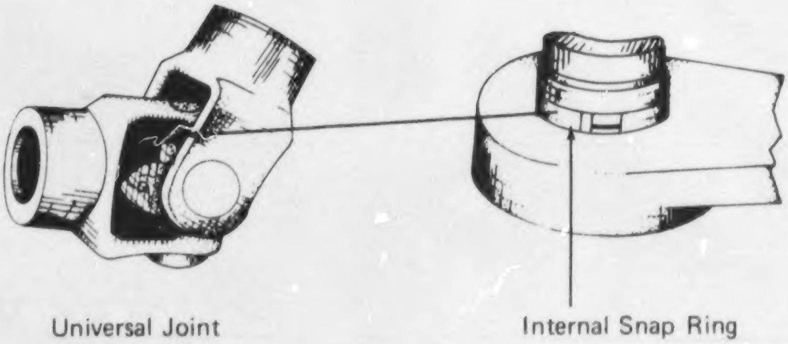
1. Remove external snap ring with pliers (Figure 2)

FIGURE 2


External Snap Ring

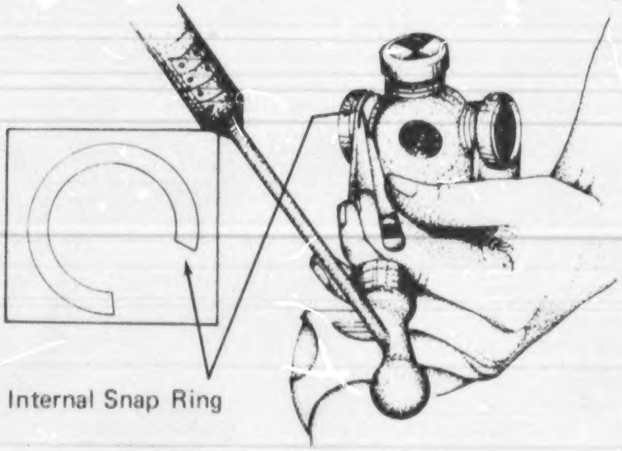
2. Remove internal snap ring with hammer and pin punch (Figures 3 and 4)

FIGURE 3


Universal Joint
Internal Snap Ring

JOB SHEET #4

FIGURE 4



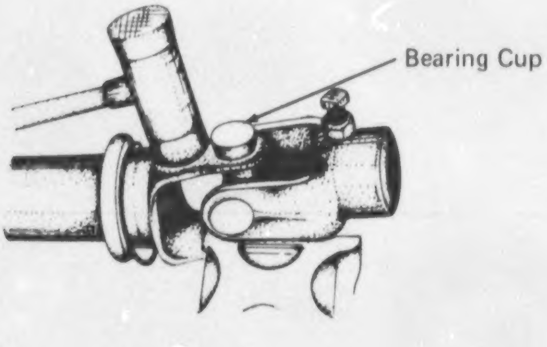
E. Remove remaining snap rings as in step D

F. Adjust vise so that vertical yoke passes freely between jaws but horizontal yoke rests on top of jaws

G. Remove one bearing cup partially by striking yoke with soft face hammer until upper fork bottoms against U-joint cross (Figure 5)

(NOTE: Bearing cup will extend above upper fork.)

FIGURE 5

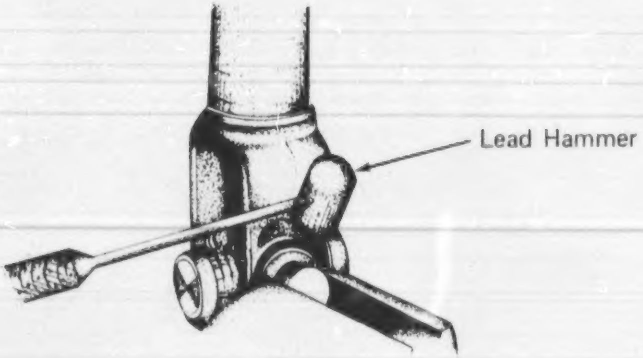


(CAUTION: Use plastic leather rubber or lead hammer. Steel hammers will damage the yoke and cause steel chips to fly off.)

JOB SHEET #4

H. Clamp the partially removed bearing cup in the vise (Figure 6)

FIGURE 6

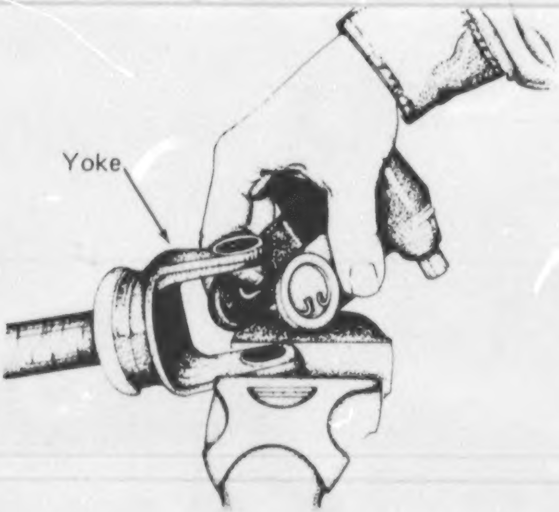


I. Strike the yoke with a soft face hammer to drive the yoke off of the bearing cup

J. Remove bearing cup on opposite side of yoke by repeating steps G through I

K. Remove cross by swinging one end of cross out of yoke and lifting cross out of yoke (Figure 7)

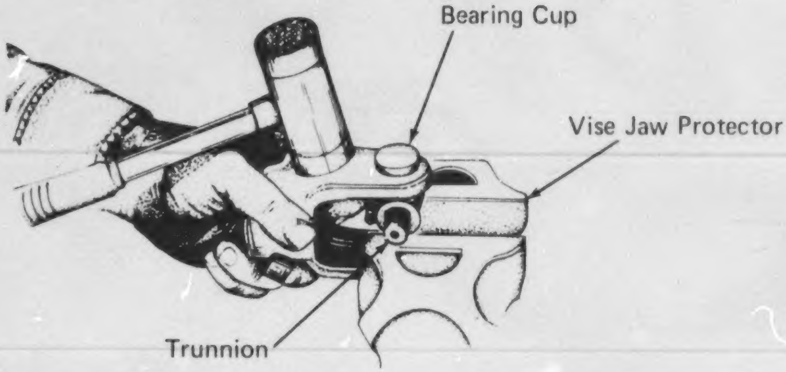
FIGURE 7



JOB SHEET #1

L. Place U-joint cross on open vise and remove remaining bearing cups by repeating steps G through I (Figure 8)

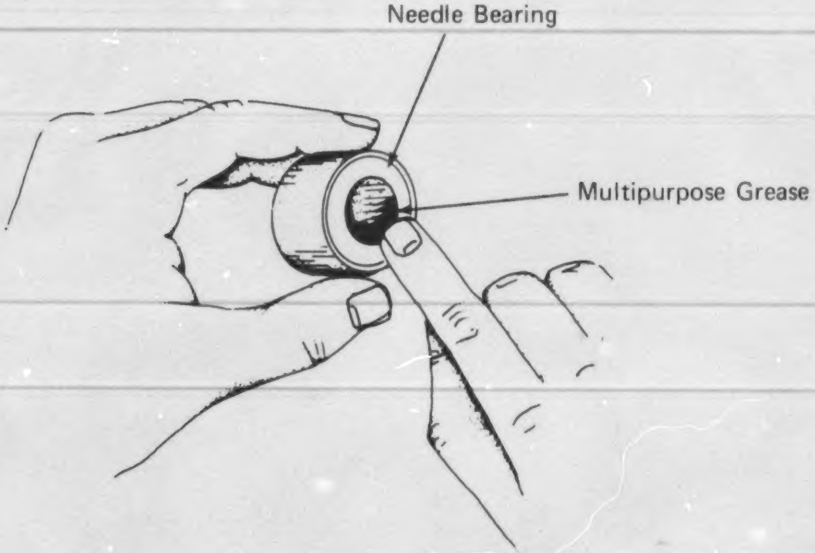
FIGURE 8


Bearing Cup
Vise Jaw Protector
Trunnion

M. Clean and inspect needle bearings and bearing cups for wear and damage

N. Pack needle bearings and bearing cups with multipurpose grease (Figure 9)

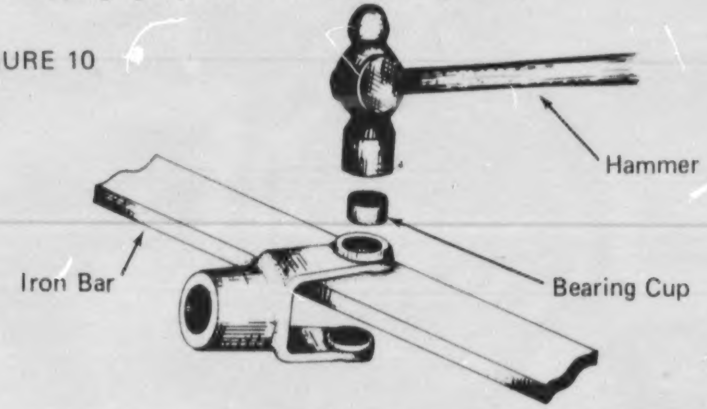
FIGURE 9


Needle Bearing
Multipurpose Grease

JOB SHEET #4

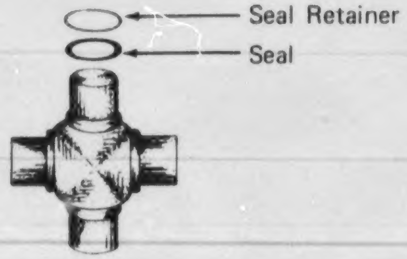
O. Rest yoke on flat surface and partially install bearing cup in one fork by tapping lightly with soft hammer (Figure 10)

FIGURE 10


Hammer
Iron Bar
Bearing Cup

P. Install grease seal and retainer on one of the cross arms (Figure 11)

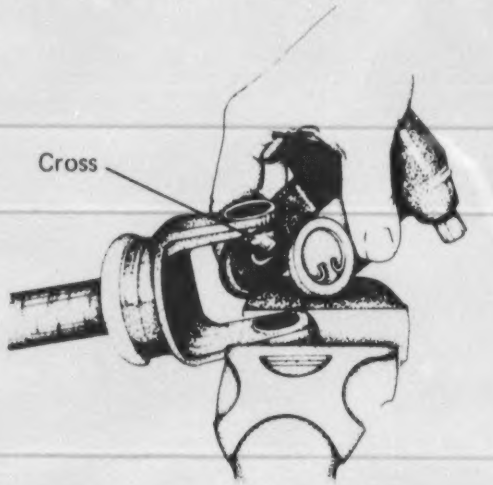
FIGURE 11


Seal Retainer
Seal

Q. Clamp yoke in vise with partially installed bearing cup on bottom

R. Insert U-joint cross into top fork opening and swing lower end of cross in and insert into partially installed bearing fork (Figure 12)

FIGURE 12

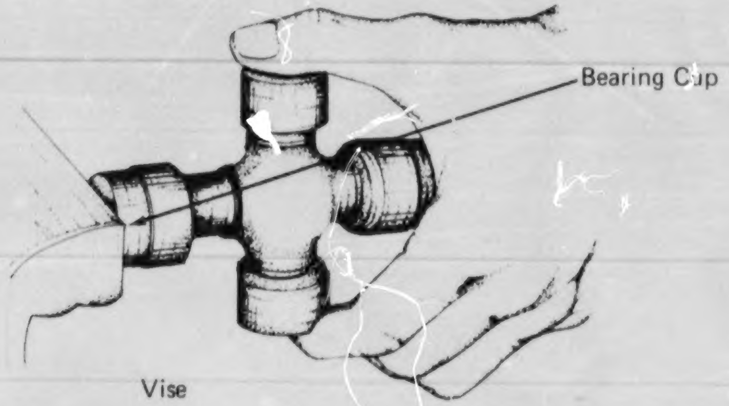


JOB SHEET #4

S. Place seal and retainer on opposite cross arm through hole in yoke fork

T. Install second bearing cup and press both cups flush with outer surface of yoke (Figure 13)

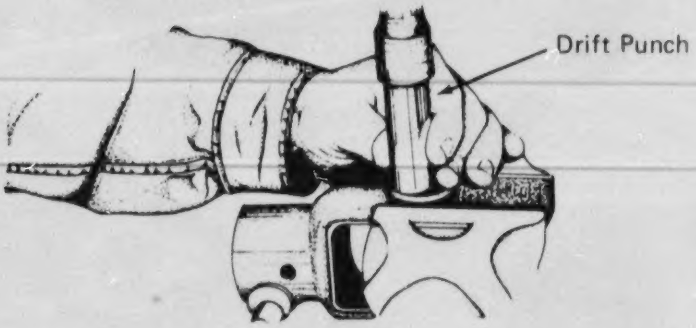
FIGURE 13



U. Drive bearing cups below the snap ring groove using a drift punch (Figure 14)

(NOTE: If difficulty is experienced exposing snap ring groove it is possible that a needle bearing has fallen into the bottom of one of the cups. Remove and inspect.)

FIGURE 14

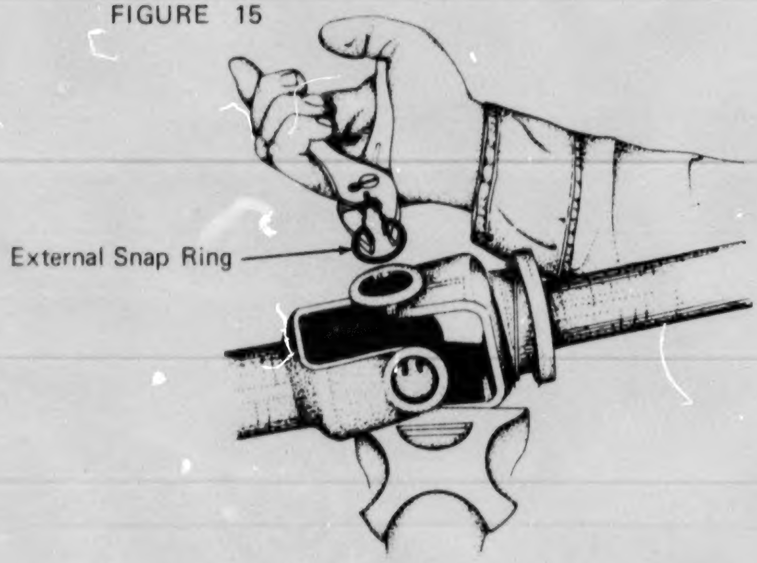


JOB SHEET #4

V. Install snap rings

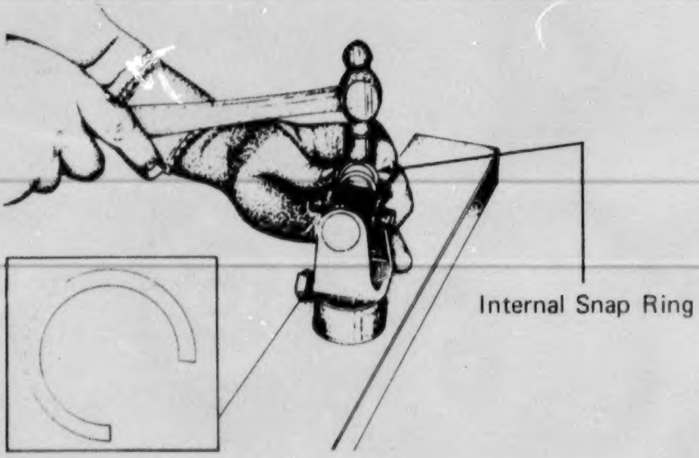
1. Install external type snap ring with pliers (Figure 15)

FIGURE 15


External Snap Ring

2. Install internal type snap rings with hammer (Figure 16)

FIGURE 16


Internal Snap Ring

JOB SHEET #4

W. Install remaining bearing cups by repeating steps O through T

X. Install remaining snap rings by repeating steps U through V

Y. Check universal joint for freedom of movement

EQUIPMENT DRIVES
UNIT I

NAME ____________________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. Source of power to operate equipment attached to the tractor

_____b. Coil of an electromagnet which produces the magnetic field when current is passed through it

_____c. Coupling device capable of transmitting rotation between two shafts not in direct alignment

_____d. Measurement from center to center of pins of drive chain

_____e. Core of magnetic material surrounded by a coil of wire through which an electrical current is passed to magnetize the core

_____f. Measurement between inside of inner plates of drive chain

1. Field coil
2. Universal joint (U-joint)
3. Power take off (PTO)
4. Electromagnet
5. Pitch
6. Width

2. Select the types of equipment drives by placing an "X" in the appropriate blanks.

_____a. Direct

_____b. Hydraulic motor

_____c. Belt

_____d. Pneumatic

_____e. PTO shaft

_____f. Ground drive

_____g. Gilmer

_____h. Chain

_____i. Electric motor

3 List one typical use of each type of equipment drive.

a. Belt--

b. Chain--

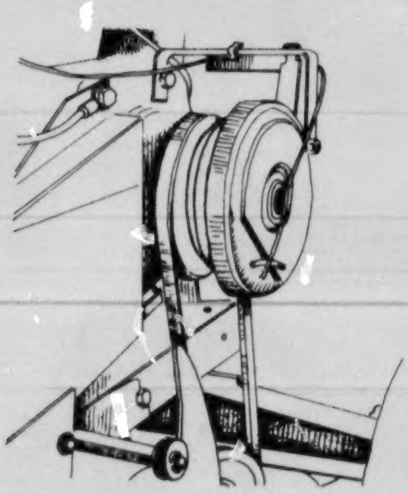
c. PTO shaft--

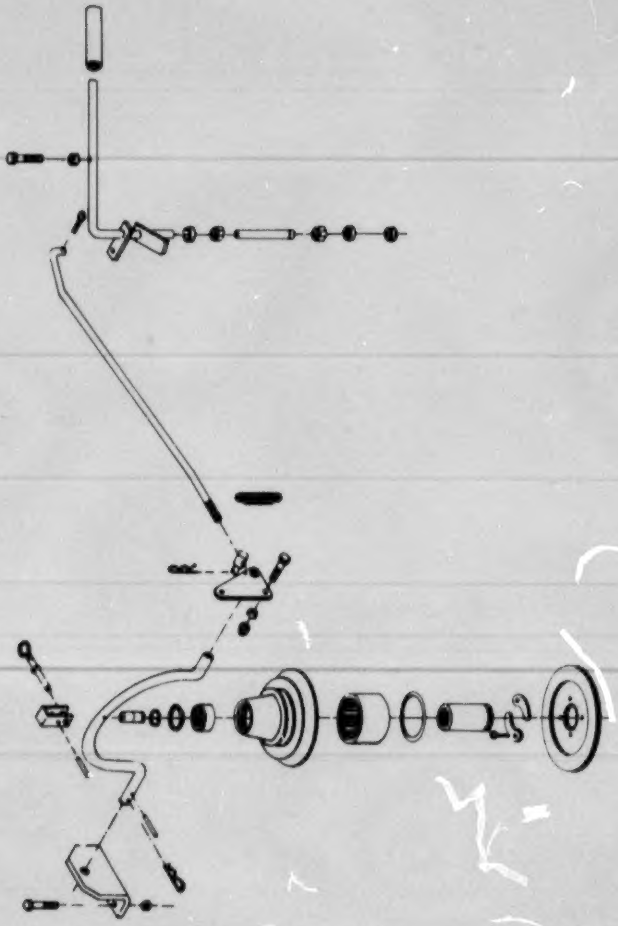
d. Ground drive--

e. Hydraulic motor--

f. Electric motor--

4 Identify the types of PTO clutches.





a. ______________________________ b. ______________________________

5. List two types of PTO power transmitting devices.

a.

b.

6. Describe the operation of PTO clutches.

7. List three drive chain size classifications.

   a.

   b.

   c.

8. Describe the operation of hydraulic motor equipment drives.

9. Match the causes on the right to the correct types of belt failure.

______a. Belt flip-over

______b. Uneven belt wear on one side

______c. Cracks between cogs

______d. Edge cord breakage

______e. Excessive glaze or baking of sides

______f. Excessive wear on top edge only

______g. Belt disintegration

1. Insufficient tension
2. Excessive belt speed
3. Excessive age
4. Improper pulley alignment
5. Rough pulley surfaces

10. Demonstrate the ability to:

a. Inspect, replace, and adjust a drive belt.

b. Remove, service, and replace a drive chain.

c. Remove, test, and replace an electromagnetic PTO clutch.

d. Disassemble and reassemble a PTO shaft universal joint.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

EQUIPMENT DRIVES
UNIT I

ANSWERS TO TEST

1. a. 3
   b. 1
   c. 2
   d. 5
   e. 4
   f. 6
2. b, c, e, f, h, i
3. Any one of the following under each section:
   a. Belt
      1) Mower
      2) Sprayer
   b. Chain
      1) Snow throwers
      2) Walk-behind tillers
   c. PTO shaft
      1) Thatchers
      2) Tractor mounted tillers
   d. Ground drive
      1) Seed spreader
      2) Reel type mowers
   e. Hydraulic motor--Mowers
   f. Electric motor--Mowers
4. a. Electromagnetic
   b. Manual

5. a. Shaft

   b. Belt

6. Description should include:

   a. Spring activated manual clutch

      1) Spring tension keeps clutch engaged

      2) Operator overrides spring tension to disengage clutch

   b. Lever activated manual clutch

      1) Engagement pressure maintained by pressure exerted by position of clutch mechanism

      2) Operator relieves tension on clutch mechanism to disengage clutch

   c. Electromagnetic clutch

      1) Electric current passing through field coil creates strong magnetic field

      2) Strong magnetic field holds clutch halves in close contact

      3) Operator controls electric current to field coil

7. a. Pitch

   b. Width

   c. Roller diameter

8. Description should include:

   a. Tractor engine drives hydraulic pump to pressurize fluid

   b. Pressurized fluid flows through flexible hoses to hydraulic motor mounted on equipment

   c. Fluid operates hydraulic motor to power equipment

9. a. 2, 4

   b. 4

   c. 3

   d. 4

   e. 1

   f. 5

   g. 2

10. Performance skills evaluated to the satisfaction of the instructor